1. Applicability

- Liquid (Regulated) Terminals
- Liquid (Non-Regulated) Terminals
- Bulk Terminals

2. Scope

This procedure provides general requirements to conduct vapor/gas testing to ensure flammable conditions do not exist and employees will not be exposed to harmful concentrations of toxic or chemical substances, or oxygen deficient atmospheres and for using and maintaining gas detectors. Follow the manufacturer’s operating instructions for the specific gas detector being used.
SQE Statement

This procedure follows Best Management Practices (BMPs), and is one of the steps necessary in establishing and implementing Kinder Morgan Terminal’s Safety, Quality, and Environmental (SQE) programs and culture.

SQE program elements were developed through aggregating best management practices and lessons learned across our organization. The elements of SQE are intended to help develop a culture where all Teammates perform their daily tasks in a manner that upholds our Core Principles, while running safe, environmentally compliant, quality focused, efficient operations. Kinder Morgan’s Core Principles are as follows:

1) Safety Will Not Be Compromised
2) Environmentally Compliant and Responsible Operator
3) Ethics and Integrity
4) Commitment to Employees and Resources
5) Customer Service and Fiscal Responsibility
6) Quality Focus

3. Definitions

3.1. Bump Test or Functional Check

A bump test or functional check verifies the instrument calibration by exposing the sensors to a known concentration of test gas at high enough concentration to activate the instrument audio, visual, and other alarms. If the instrument's response is within the manufacturer’s tolerance range of the actual test gas concentration, then calibration is verified. If the test results are not within the acceptable range, a full calibration of the instrument must be performed.

3.2. Calibration

A calibration is the adjustment of an instrument’s readings to match a known concentration of test gas. For verification of accuracy, the calibration gas should be certified by and traceable to the National Institute of Standards and Technology (NIST).

3.3. Hazardous Location

Hazardous locations can be classified based on the following:

- The possible presence of an explosive atmosphere such as flammable gases, vapors, or liquids (Class I), combustible dusts (Class II) or ignitable fibers (Class III).
- The likelihood that an explosive atmosphere is present when equipment is operating under normal conditions, undergoing repair or maintenance operations, or because of leakage (Division 1) or an explosive atmosphere would likely be present as a result of unusual operating condition, or accident (Division 2)
- The ignition related properties of the explosive atmosphere that is present.(Group)
  - Group A – Acetylene
  - Group B – Hydrogen or gases of equivalent hazard
  - Group C – ethyl ether, ethylene, or cyclo propane
  - Group D – gasoline, hexane, naptha, benzene, butane, propane, alcohol, benzol, lacquer solvent, or natural gas
  - Group E - metal dust
  - Group F – carbon, coal, coke
  - Group G – grain dust
3.4. Hazardous Atmosphere

Atmospheric conditions that may expose employees to a risk of death, incapacitation, impairment of ability to escape unaided, injury or acute illness from one or more of the following:

- Flammable vapor/gas or mist in excess of 10% of the lower explosive limit (LEL).
- Airborne combustible dust at a concentration that meets or exceeds the LEL. This may be estimated as a dust concentration which obscures vision at a distance of five feet or less.
- Atmospheric oxygen concentration below 19.5% or above 23.5%.
- An atmospheric concentration of any substance in excess of its OSHA Permissible Exposure Limit (PEL) as listed in 29 CFR 1910, Subpart Z or any other OSHA substance-specific standard. If no OSHA limit exists, the American Conference of Governmental Industrial Hygienists Threshold Limit Values (TLV) shall be used.
- Any other atmospheric condition that is Immediately Dangerous to Life or Health (IDLH).

3.5. Hot Work

Work involving burning, welding, or a similar operation that is capable of initiating fires or explosions.

3.5.1. Use of flammable vapors/open flame generating high heat. Cutting, brazing, soldering, heating, etc.

3.5.2. Use of an electric or arc welder.

3.5.3. Chipping, ripping, cutting by impact, and grinding of metallic or non-metallic material/substrates using potentially spark-producing tools.

3.5.4. Use of explosion charged powered equipment.
3.6. Immediately Dangerous to Life or Health (IDLH)

Any condition that would pose an immediate or delayed threat to life, cause irreversible adverse health effects or interfere with an individual’s ability to escape unaided from a space.

3.7. Intrinsically Safe

Incapable of releasing sufficient electrical or thermal energy under normal or abnormal conditions to cause ignition of a specific flammable or combustible atmospheric mixture in its most easily ignitable concentration. The basic test for intrinsic safety is ANSI/UL 913-1988.

3.8. Lower Explosive Limit (LEL)

The lowest concentration of a flammable vapor/gas in air which shall ignite if an ignition source is applied.

3.9. Oxygen Deficient Atmosphere

Atmospheric conditions containing less than 19.5% oxygen by volume. These atmospheres present a potential asphyxiation hazard.

3.10. Oxygen Enriched Atmosphere

Atmospheric conditions containing more than 23.5% oxygen by volume. These atmospheres present a potential fire and explosion hazard.

3.11. Parts Per Million (ppm)

A unit for measuring the concentration of a vapor/gas in air - parts (by volume) of the vapor/gas in a million parts of air. Also used to indicate the concentration of a particular substance in a liquid or solid.

3.12. PEL (Permissible Exposure Limit)

The permissible concentration in air of a substance to which nearly all workers may be repeatedly exposed 8 hours a day, 40 hours a week without adverse health effects. Established by the Occupational Safety and Health Administration.

3.13. TLV (Threshold Limit Value)

Level used by the American Conference of Governmental Industrial Hygienists (ACGIH) to designate degree of exposure to contaminants. An exposure level under which most people can work consistently for 8 hours a day, daily, with no harmful effects.


The Operating organization is responsible for the designation and preparation of equipment for work, including any associated vapor/gas testing. In defining the job to be done, it may be necessary to consult with personnel from other departments, i.e., the group performing the work. When the equipment has been selected and the job defined, the responsible person will ensure proper preparations of the equipment that may include:

- Draining
- Washing with water
- Ventilating with air
- Steaming
- Purging
- Cleaning
- Lock-out
- Isolation of equipment

When the equipment has been properly prepared, the “job site” is ready for vapor/gas testing. The vapor/gas testing required to fulfill Work Permit Program (Safe Work, Confined Space, Hot work permits) is detailed in the following headings:

3.14.1.1. Hot Work Permit

If hot work is to be performed in an area where flammable mixtures may be present, a vapor/gas test for oxygen and flammable vapors/gas MUST BE PERFORMED. Tests for toxic substances must also be performed when their presence is suspected.

3.14.1.2. Confined Space Entry Permit

When entry into a confined space is required, Vapor/Gas Tests for oxygen and flammable vapors MUST BE PERFORMED. Tests for toxic substances must also be performed when their presence is suspected.

3.14.1.3 Excavations

Before entering an excavation that is four feet or greater in depth, perform testing for oxygen-deficient, flammable and combustible vapors, and toxic substances when suspected.

Test before beginning Hot Work when excavating a pipeline.

4. Core Information and Requirements

Keep gas detectors in good working condition and readily available at the work location. Use a vapor/gas detector when there is a potential for unsafe atmosphere, such as:

- During confined space entry and work
- Before beginning any hot work unless conducted in a designated safe hot work area.
- Before entry into excavations four feet or greater in depth.
- When signs of a possible leak on the pipeline (dead vegetation, persistent bubbles in water, etc.) are detected

4.1. Flammable Property of Combustible Gases

When flammable or combustible gas is introduced into an area, the gas gradually displaces fresh air. During this process, the air/gas mixture passes through three specific regions: lean, explosive and rich.

4.1.1. Lean Region

Mixtures in the lean region, which extends from fresh air to the lower explosive limit (LEL), will not burn since they contain too little gas in relation to air.

4.1.2. Explosive Region

LEL is the lowest concentration of combustible vapor/gas in air that will explode or burn when ignited. The upper explosive limit (UEL) is the highest concentration of combustible gas in the air that will explode or burn when ignited.

Reference applicable MSDS for guidance on the properties of specific products and chemicals.
4.1.3. Rich Region

Vapor/gas(Gas) and air mixtures in the rich region, which extends from the upper explosive limit to pure vapor/gas, contain too much vapor/gas to be combustible (i.e., there is not enough oxygen to sustain combustion). However, this region must be considered equally dangerous, since air introduced into this environment can create an explosive environment.

4.2. Performing Vapor/gas/Gas Tests

Before going to work on the site, the vapor/gas tester must:

- Understand the specific equipment involved and the vapor/gas tests to be performed.
- Ensure the LEL/O2/PPM/CO meter is functioning.
- Carry out battery and meter adjustment checks each time and instrument is used.
- A functional check (bump check) of the oxygen and combustible vapor/gas meters must be carried out prior to use
- Select the correct detection equipment when tests for toxic substance(s) are specified. (See Appendix I for listing.)

Perform vapor/gas tests in accordance with the following guidelines:

4.2.1. Confined Space

When entry into a confined space for testing is necessary, the vapor/gas tester must be provided with supplied air respiratory protection and any other protective equipment that may be needed.

Perform vapor/gas tests throughout Confined Space and in areas where it may be possible for vapor/gas or liquid to be trapped.

Perform vapor/gas tests in all levels of the space. Some vapors are heavier than air and tend to fall to the bottom and some vapors are lighter, and will rise to the top.

4.2.2. Excavations

Where oxygen deficiency (atmospheres containing less than 19.5 percent oxygen) or a hazardous atmosphere (greater than 10% lower flammable limit [LEL]) or toxic (H2S, CO, etc.) exist or could reasonably be expected to exist, the atmospheres in the excavation shall be tested by a competent person before employees enter excavations greater than 4 feet (1.22 m) in depth. Retest the area throughout the day or when conditions change.

4.2.3. Inert Atmospheres

Using a vapor/gas tester to analyze an inert vapor/gas atmosphere can produce a false reading. Consult the manufacturer for special vapor/gas test equipment adapter requirements.
4.2.4. Open Areas

The primary concern in open areas is flammable/combustible vapor. Vapor/gas tests for toxic substances should also be conducted if their presence is suspected.

Vapor/gas tests should be made at all openings of the equipment and in the area surrounding where the work is to be performed.

Test at sewer openings, open vents, bleeds and at any other possible locations in the area where leaks may be suspected.

4.2.5. General

For a vapor/gas test to be valid, it should be performed as close as possible to the time work in the tested area begins.

Continuous gas monitoring (Hazardous Atmosphere Testing) shall be conducted for the following work locations/activities:

- Permit required confined spaces and reclassified confined spaces
- Hot work performed outside of designated areas (e.g., outside of the welding shop or area)
- Hot work within the electrical classified areas of the facility (e.g., vehicle entry into secondary containment, welding/cutting/grinding on in-service equipment)

Gas monitoring for activities not covered above must be repeated when:

- Two or more hours pass between the test and the start of the work.
- The work is stopped and resumes at a later time.

4.2.6. Documentation

Record the results of the vapor/gas tests and sign the applicable work permit.

- In cases of continuous monitoring, record the results of the tests at least every two hours.

4.3. Vapor/Gas Testing Instruments

The following types of instruments are preferred for vapor/gas testing.

4.3.1. Dual Purpose Instruments

Dual-purpose instruments that are designed to monitor areas for flammable/combustible vapor/gas and oxygen deficient atmospheres. The concentration of flammable/combustible vapors in the sampled area is measured as the percent of the lower flammable limit in the air and the percent oxygen in the sampled area.
4.3.2. Maintenance and Calibration

(Note: Only trained employees can conduct maintenance and calibration).

To ensure proper operations and meter responses, it is important to maintain and calibrate all instruments. The following establishes responsibilities and methods by which maintenance and calibration will be accomplished.

- Purchase a calibration kit from the vendor. Use the calibration kit to verify meter calibration when used on a continuous basis in accordance with the manufacturer.
- Using a known vapor/air mixture to ensure the meter response is accurate performs calibration. Record the calibration checks in an appropriate log.
- Place a "calibrated" sticker on instruments immediately after calibration. Include date and initials of person performing the calibration.
- Vapor/gas test instruments not operating properly or unable to calibrate should be tagged “Danger – Do Not Operate” and sent to the appropriate vendor for necessary repair.
- Calibrate per the manufacturer's instructions (quarterly at a minimum) and document. Records should show date of calibration, who performed (initials/name), and have a notation of any discrepancies or problems with the calibration. Calibration stickers on meters may be used, but are not required. Stickers cannot be used in place of calibration records and documentation as described.

4.4. Drager Chip Measurement System (CMS) and or Detector Tubes

The CMS draws measured amounts of air through a glass tube. The Tubes contain a specific substance that reacts selectively with certain chemicals to change the color of the materials in the tube.

The concentration of a particular chemical in the sampled area is measured as parts per million, PPM.

Tests for a wide variety of containments can be made with this instrument utilizing specific CSM or detector and tubes.

4.4.1. Operating the Detector

Perform initial instrument operating check before placing the detector in use per the manufacturer's instructions. The Drager CMS unit requires no field calibration but rather self indicates after 1,000 readings to return to the manufacturer for calibration. The individual chips will also have a shelf life stamped on them. The only other service required is to change the alkaline batteries. To accurately measure the concentration of gas in an area, follow the manufacturer's instructions closely.
4.4.2. **Warnings**

When testing atmospheres containing certain gases/vapors, such as leaded gasoline, take care to prevent damage or incorrect readings. In the case of leaded gasoline, the catalytic sensor may become coated with lead after several measurements, causing sensitivity to be lost. Always check the manufacturer’s manual for these precautions.

A potential explosion hazard exists any time 10% LEL is reached. When 10% LEL is reached (10% LEL for confined space work), stop work, identify the source of flammable gas and ventilate the area until readings are reduced to safe levels.

**Note:** To properly interpret equipment alarms or indicators, each employee must be familiar with operating the particular type and model of equipment being used. Explosion hazards may be indicated differently, based upon the various manufacturers' designs.

4.5. **Optional Sampling Equipment**

4.5.1. **Sampling Lines**

Most manufacturers sell sampling lines that can be connected to gas detectors, allowing samples to be taken at remote or inaccessible locations, such as manholes, sewers and bell holes. Always use sampling lines for the specific detector and follow the manufacturer's instructions.

**Warning:** Do not use sampling lines made of ordinary rubber or any synthetic material, which can absorb solvent vapors. This will result in incorrect readings that are usually lower than the actual value.

4.5.2. **Probes**

Probes permit samples to be taken in areas that cannot be reached with a sampling line. Connect a probe to a sampling line to examine bell holes, manholes and sewers, behind obstructions or areas accessible only through narrow openings. Use only manufacturer-provided probes.

**Warning:** Do not use an electrical-conducting probe where shock hazards exist (where contact may be made with electrical equipment or power lines). Use high dielectric plastic probes, which do not conduct electrical current, in these areas.

4.6. **Maintenance**

Follow the manufacturer’s instructions for routine and special maintenance. Most instruments require service annually.

4.6.1. **Warnings**

Do not purge the instrument with compressed air. Compressed air may contain oil and/or water, which can damage internal components.

Be sure flashback arresters are installed in the instrument. Do not reuse flashback arresters; they will not fit properly in the sleeve and may not prevent flame propagation.
5. Training

A properly trained and certified atmospheric tester will test all Hot Work areas, permit required confined space entry, and safe work permits where enter into excavations four feet in depth or greater prior to work being performed. The tester must be knowledgeable on use of applicable equipment.

Individuals responsible for performing atmospheric monitoring must be trained and competent in the following at a minimum:

- Calibration, use and, limitations of the vapor/gas detection equipment they will be using.
- The fundamentals of vapor/gas detection.
- The fundamentals of hazard communication (exposure limits, flammable ranges, etc.).
- The basic properties of the materials that may be present. (Review the specific Material Safety Data Sheet.)
- If testing a confined space they need additional training on confined space entry.
- Proper use, care, and daily function check on equipment according to manufacturer’s specifications.
- Limitations of atmospheric test equipment as detailed in manufacturer’s specifications.

5.1. Training Frequency

5.1.1. All personnel involved in atmospheric testing must be trained on their specific duties.

5.1.2. Initial Training - Before completing any tasks outlined in this document.

5.1.3. Refresher Training – Annually, review Business Unit Training Matrix.

6. Documentation

Keep a record of initial and maintenance checks on gas detectors. Document all calibrations.

7. References

- T-O&M Procedure 100, Employees O&M Responsibilities
- T-O&M Procedure 103, Safety Permit
- T-O&M Procedure 109, Excavating, Trenching, and Shoring
- T-O&M Procedure 134, Confined Space Entry
- T-O&M Procedure 1700, L-I&M Procedure i-0531.00, L-I&M Procedure I-0531.00, or equivalent inspection / testing maintenance process.
- Manufacturer operations manuals for gas detectors
- Canada Labor code Part XI – Confined Spaces
- Work Safe BC Part 9, Confined Space Section 24 – Verification and Testing