



gas and vapour detection

M&C- remote permit

For use by Remote Permitting Contractors
at NA Retail and C&I Petroleum facilities

gas detection

Typical gas detection equipment includes:

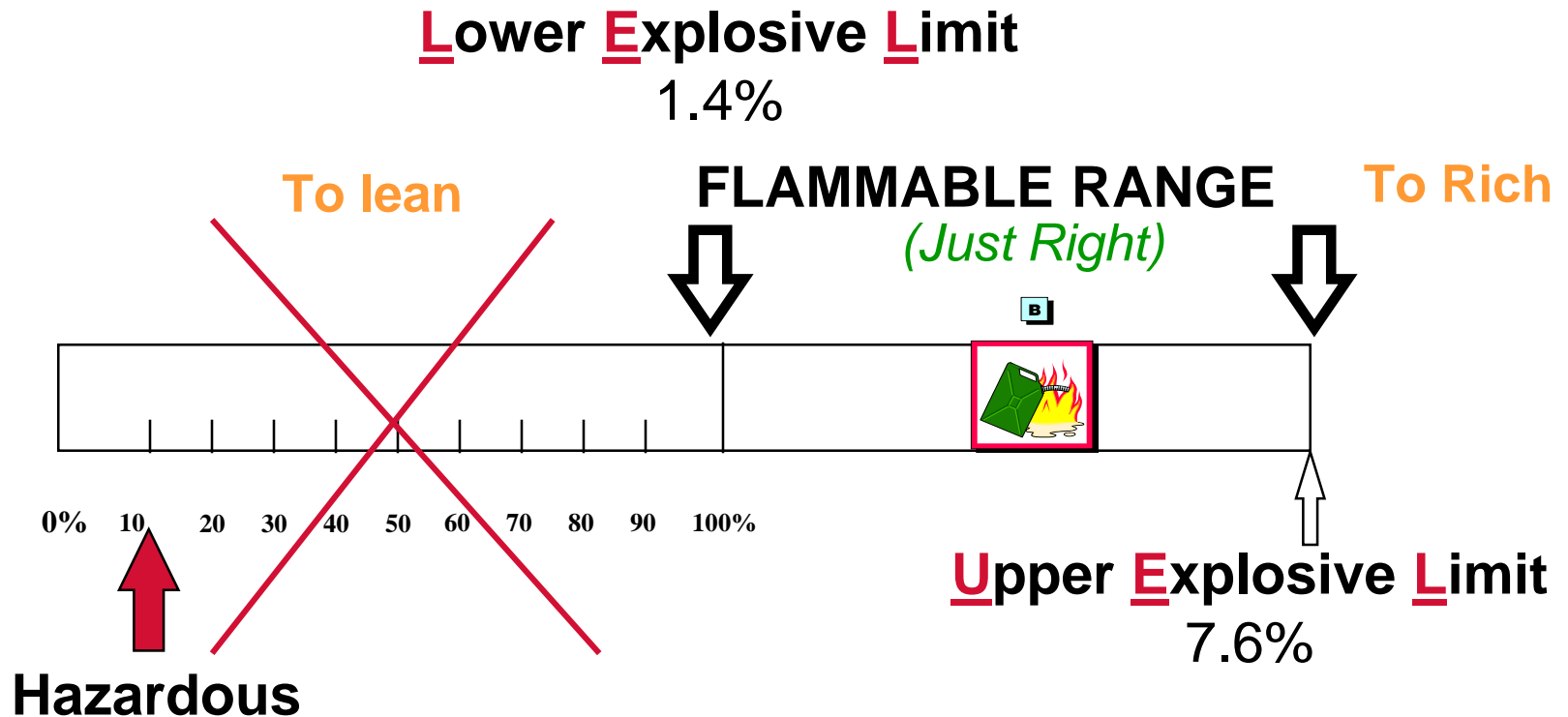
- LEL Meters equipped with a catalytic cell as a combustible gas sensor
- Meters equipped with electrochemical sensors for the measurement of O₂, H₂S and CO.
- Detector tubes, also called “colorimetric tubes”

Alarm Levels are set as follows:

- Oxygen: 23%
 - Flammables: 5% LEL
 - CO: 25 ppm
 - H₂S: 5 ppm
- The low alarm on oxygen is set at 19.5%



combustible sensor reads percent of LEL



Example : gasoline or avgas

the combustible sensor

- It is usually a catalytic cell that burns the sample
- It gives a reading in **% of the LFL/LEL**
- It requires a **minimum amount of oxygen** to burn and to give a reading (typically at least 15% O₂)
- That is why we need to check the oxygen
- Overexposure to flammables rapidly degrades the sensor



Catalytic cell Industrial Scientific.avi

Video clip was provided by
Industrial Scientific

Catalytic cell

reading on the combustible sensor

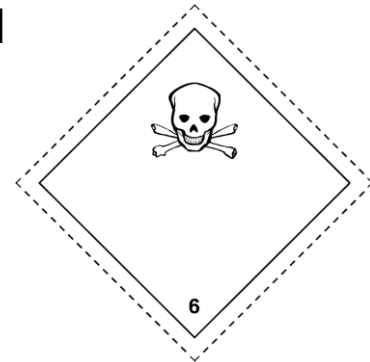
- The catalytic sensor is **non specific**. It burns the sample and heats the filament inside. It can therefore detect all flammable gases and vapors.
- The amount of energy generated during the heating process is compared to a reference point.
- The sensor **might not** detect vapors off a combustible liquid such as Jet or Diesel if the temperature of the sample is several degrees lower than its flash point.

NOTE: A lot of people do not realize that if the combustible liquid does not give off a sufficient amount of vapor, the reading could be zero. The flash point of diesel and jet in some countries (such as Canada) is around 130 °F, 45 °C. Combustible liquid give off vapor below their flash point however they are very slow. If the equipment or container was not in direct heat or sunlight, the amount of vapor might be so low that the combustible sensor might not react.



damaging the combustible sensor

- Catalytic sensors for combustibles can be “**poisoned**” by certain substances such as:
 - Tetraethyl lead and tetra methyl lead (found in avgas and in leaded gasoline tanks)
 - Silicone products
 - Some hydraulic fluids and lubricants.
- While the sensor first loses sensitivity on Methane gas, **the preference is to calibrate the detector with Pentane or Pentane Simulant** made out of Methane.



electrochemical sensors

- The sensors for oxygen, CO and H₂S are electrochemical sensors.
- They are **SPECIFIC**, however the reading can be affected by the presence of other products (check the manufacturer's manual for interferences).
- Contrary to the combustible probe (LEL) they are not affected by a low concentration of oxygen, they still give a reading.
- Too much CO₂ rapidly degrades the oxygen sensor.



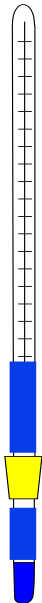
always conduct “fresh air setup”

- The oxygen sensor is affected by differences in altitude (partial pressures)
- It must be ZEROED before each use including before calibration or bump testing (on some instruments this operation is called Fresh Air Set Up or the Zero).
- Zeroing calibrates Oxygen to 20.9%
- It must **always** be done in CLEAN air.
- It also adjusts the CO and H₂S sensors to zero.



influenced by temperature variances

- If the detector goes from a “cold” or air conditioning environment to a “hot” environment (or vice versa), there will be condensation inside and the possibility of a **false reading** from the sensors.
- A variance of 10 °F (5 °C) is usually too much for the detector.
- It is recommended to store the instrument at ambient temperature (if feasible) or to let it stabilize for several minutes at the temperature at which readings will be taken (about 30 minutes). Check your handbook.
- The detector must however always be stored in a clean, dust free environment. **It is NOT recommended to leave the detector inside a vehicle.**



review of gas detection equipment storage requirements

- Gas detection equipment should be stored in a dry, dust free environment away from chemical vapors. Storage locations should ideally be at the same, or similar, temperature to the location where the instrument is to be used.
- When an instrument is stored at a temperature significantly different ($\pm 5^{\circ}\text{C}$ [$\pm 10^{\circ}\text{F}$]) to the temperature where the testing is to be performed, then the user must ensure sufficient time for the instrument to temperature stabilize prior to use.
- This stabilization time may vary from 5 minutes to more than 30 minutes depending on the instrument design and construction materials.



review of testing techniques

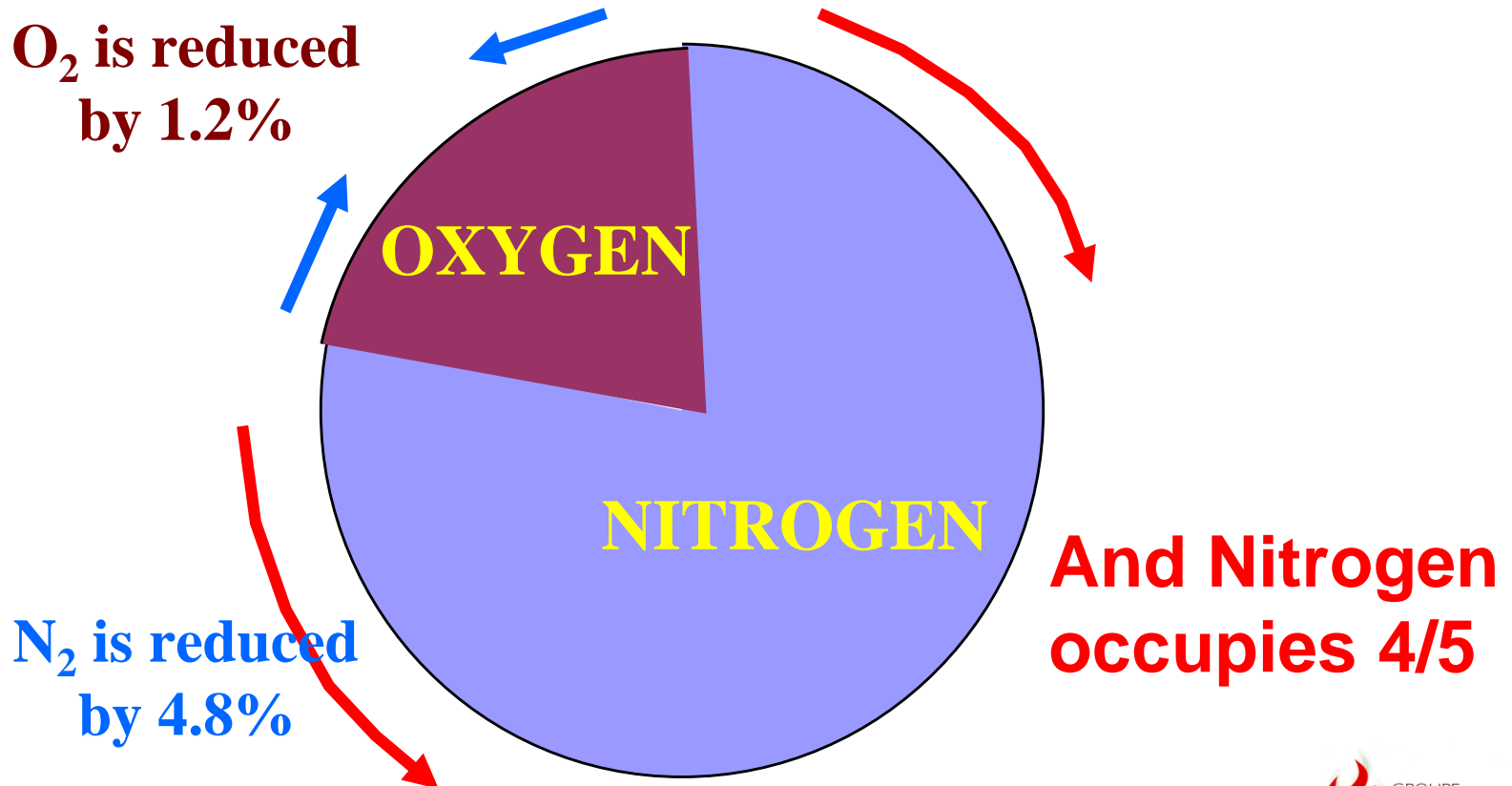
- Tests for Oxygen should be conducted prior to tests for LFL/LEL. Many instruments require a minimum amount of oxygen to function correctly, typically around 15% or higher, otherwise the instrument may read LFL/LEL incorrectly
- GAS TESTING IN FOLLOWING SEQUENCE
 - Oxygen
 - Flammables (in % LFL or LEL)
 - Toxicity
- Toxicity readings required are identified on the Work Permit/Form and the on the JLA
- Measured with a toxic sensor on the electronic gas detector or with detector (colorimetric) tubes using a manual detector pump.

if reading of oxygen is low, find out why

- Oxygen can be displaced by:
 - oxidization of metals
 - gases such as nitrogen or CO₂ gas (or dry ice) during inerting process
 - by CO₂ given off by bacteria that are breathing
 - the presence of another gas or vapor
- It might still not be safe if O₂ = 19.6%, ventilate, if readings are not adequate, try to find out **WHY**
- A loss of 1.2% oxygen might represent a lot more than 12,000 ppm of something else, the gas present has also displaced the nitrogen contained in the air (in a proportion of 1 to 4)

if oxygen goes down by 1.2%, there could be 6% of another gas!

Since Oxygen occupies 1/5 of the space



too much oxygen is a fire hazard

- In an enriched oxygen atmosphere combustibles **become more flammable**.
- They require less energy to burn (typically 100 times less energy)
- Instruments are **not intrinsically safe** in high oxygen (> 23%)
- Oxygen sticks to hair and clothing, a small spark and **you ignite!**



gas detection review

- Gas testing equipment must be maintained in good operating condition. The following are required:
 - Daily Bump Tests
 - Monthly Calibration
- Manufacturers' Calibration (annual or as recommended)
- Maintain written records of calibration for their gas detection instruments and provide a copy of these records upon request
- Gas testing is to be conducted only by qualified and competent personnel
- Record the results of gas tests they undertake, and date and time of tests on the appropriate Permit documentation



calibration and test gas selection

- Where a selection of calibration gases are recommended by the manufacturer for testing the LFL/LEL sensor, the preference will be to calibrate with Pentane or on a methane in air mixture, also referred to as Pentane Simulant.



Note: When assessing most light hydrocarbon vapors such as gasoline, no correction is needed if Pentane or Pentane Simulant is used as the calibration gas for LEL. The use of methane and not a methane in air mixture (pentane simulant), requires the use of a response curve to correct readings.



calibration and test gas

- The following should never be used to Bump test or calibrate instruments:
 - Gasoline
 - Naphtha
 - Test gases of unknown concentration
- Always ensure that the Calibration or Test Gas is current and has not expired.



Check Expiration Date

- Test gases should be checked prior to use to ensure they are within their service life

Note: Calibration tests conducted with expired gases are not reliable.



equipment inspection before use

- The qualified gas tester must, as a minimum, perform the following inspections before using any portable gas detection equipment:

Step	Action
1	Check the battery has sufficient charge
2	Check the Daily Response Check Sheet. If not available or no test done for the day, perform a Bump Test (Response Check) and record.
3	Check the Field Calibration Record Sheet. If not field calibrated within last month have a field calibration done
4	Check the Manufacturers Calibration Record. If not current do not use the instrument and arrange for a manufacturers calibration



equipment inspection before use

Step	Action
5	Check the instrument, and all accessories to ensure they are in good condition
6	Check the filter (if fitted) and water trap (if fitted) for cleanliness. Clean or replace if necessary
7	Check the probe and sampling lines (if used) to ensure they are connected properly, washers fitted, not leaking, free of obstruction and the required length



bump testing

- Gas testing equipment must be maintained in accordance with the following:
 - **Bump Tested** - Gas detection instruments will be Bump Tested daily, or each time they are used to ensure sensors are working within the respective calibration range and the alarms work at appropriate set points. **Daily bump test results must be recorded and made available for review at the job site.**

Bump test records should be specific for each instrument and include a pass or fail status.

Note: Whenever the instrument fails bump test, it MUST be calibrated



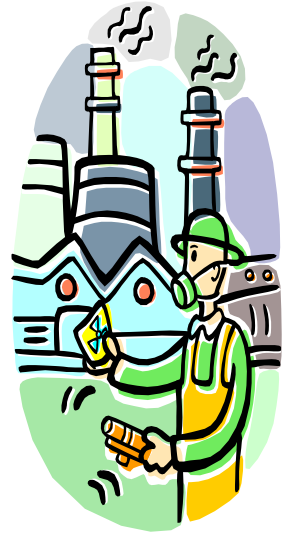
Bump Test Record
 Make and Model: _____
 Instrument No.: _____

Year:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009												
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Initial if Bump Test Passed otherwise indicate Bump Test Failed

determining gas or vapour concentrations

- Gas testing is undertaken to determine the presence of flammable and or toxic vapour or gas, and at what concentration are present.
- Gas Testing is done to ensure that no hazardous work conditions exist from the presence of such gases or vapours.
- The principal areas of concern for human safety are:
 - Determining oxygen levels (deficiency or enrichment)
 - Determining explosive risks (flammability)
 - Determining health risks (toxicity)



planning for gas tests

- Prior to commencing work in an area which may contain hazardous gases or vapours the person in charge (GC or Maintenance contractor) should identify hazardous substances or conditions that may require gas testing, such as:
 - Oxygen deficiency or enrichment
 - Flammable gas or vapor
 - Toxic vapours such as:
 - benzene or organic lead
 - Hydrogen sulfide
 - Carbon monoxide
 - Carbon dioxide
- During the planning stage for proposed work the following should be determined;
 - The types of gases that need to be tested for;
 - What the acceptable limits are;
 - The frequency of gas testing required



portable gas testing equipment

- As a minimum all portable gas detection equipment systems will include the following components:

- The instrument handbook
- The manufacturers accessories as appropriate
- Calibration kit (or bump test/response check kit)
- Spare, fresh batteries of the approved type, or the approved battery charger
- Consumable spares, e.g. Filters
- The gas detection instrument



review manufacturers precautions

- Prior to using gas detection equipment the user must be aware of any manufacturers precautions. Review the Owner's Manual and Operating Manual for your specific gas detection equipment (if you don't have these, get them!).
- These may vary depending on the manufacturer and type of sensor being used.
- Typical warnings that may apply include:
 - Oxygen deficient or oxygen enriched environments may cause erroneous LEL readings.
 - Ensure sufficient battery charge before use.
 - Only recharge or change batteries in a non-hazardous area.
 - Do not draw liquid into the sampling line.
 - Only zero the instrument in clean air.
 - Sampling environments with more than 100% LEL may provide erroneous LEL readings.
 - Do not remove instrument from it's case when in a hazardous environment.



equipment inspection before use cont.

Accessories

- Use only manufacturer-approved accessories with your instrument
- Incorrect accessories can compromise the operation of the instrument; for example, a non-approved sample line may contain silicone compounds that can poison the detection filament



standard instructions

The General Work permit shall specify when gas testing is to be performed:

- Prior to general work in an area where hazardous atmospheres may exist.
- Prior to Hot Work in a classified hazardous area.
- Prior to Confined Space Entry



gas testing for hot work

Tests for flammable vapour and/or other hazardous vapours/gases must always be undertaken before

- Any hot work is performed in a **classified hazardous area (see next slide)**
- Before any general work is performed within a classified hazardous area where there is a high risk that a hazardous atmosphere may exist.

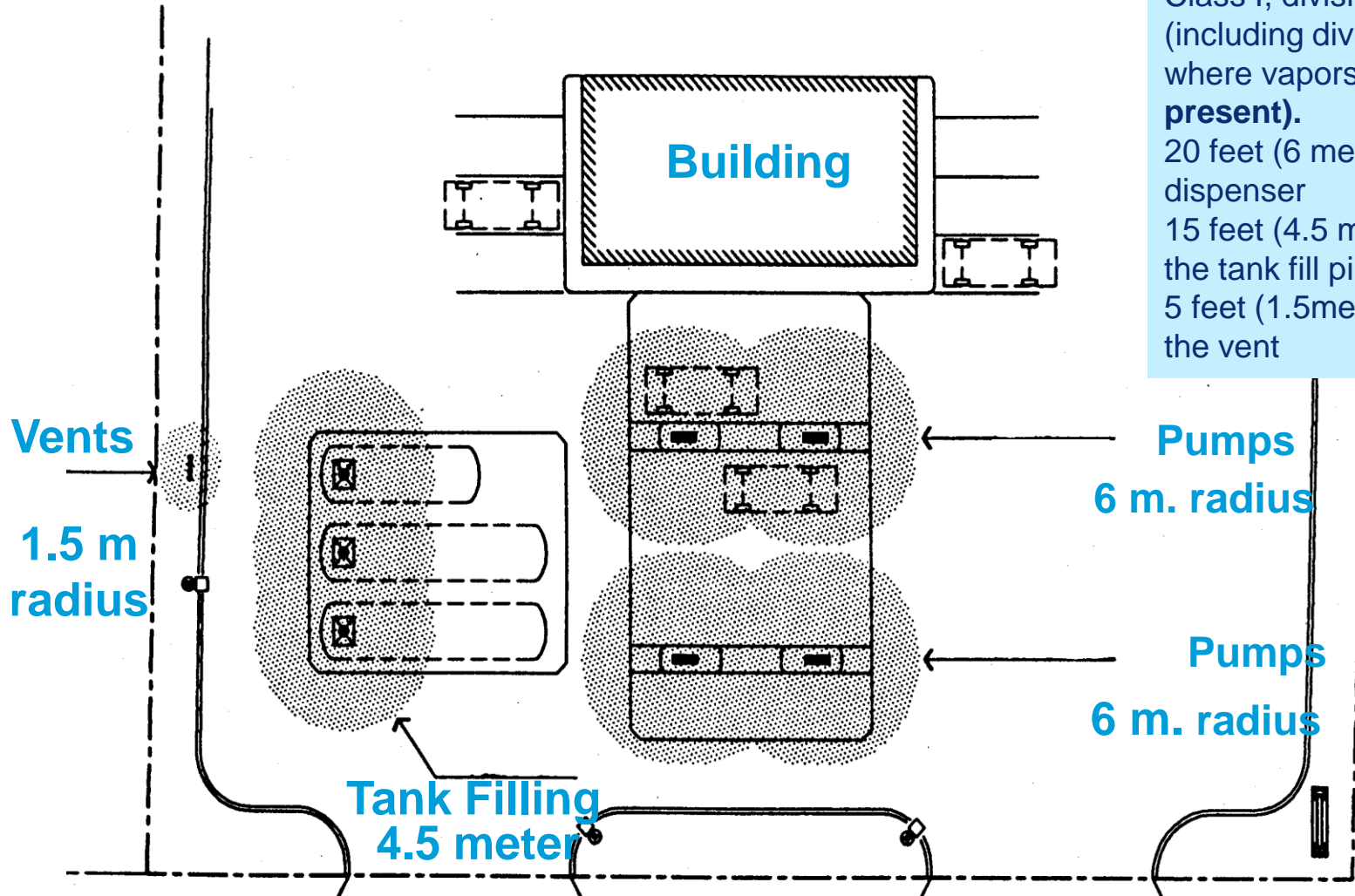
Safety Consideration

Work will not be allowed to proceed if gas levels exceed those specified in the Contractor Safety Orientation or other relevant Standards as appropriate to the work situation, e.g. confined space entry, excavation, hot work

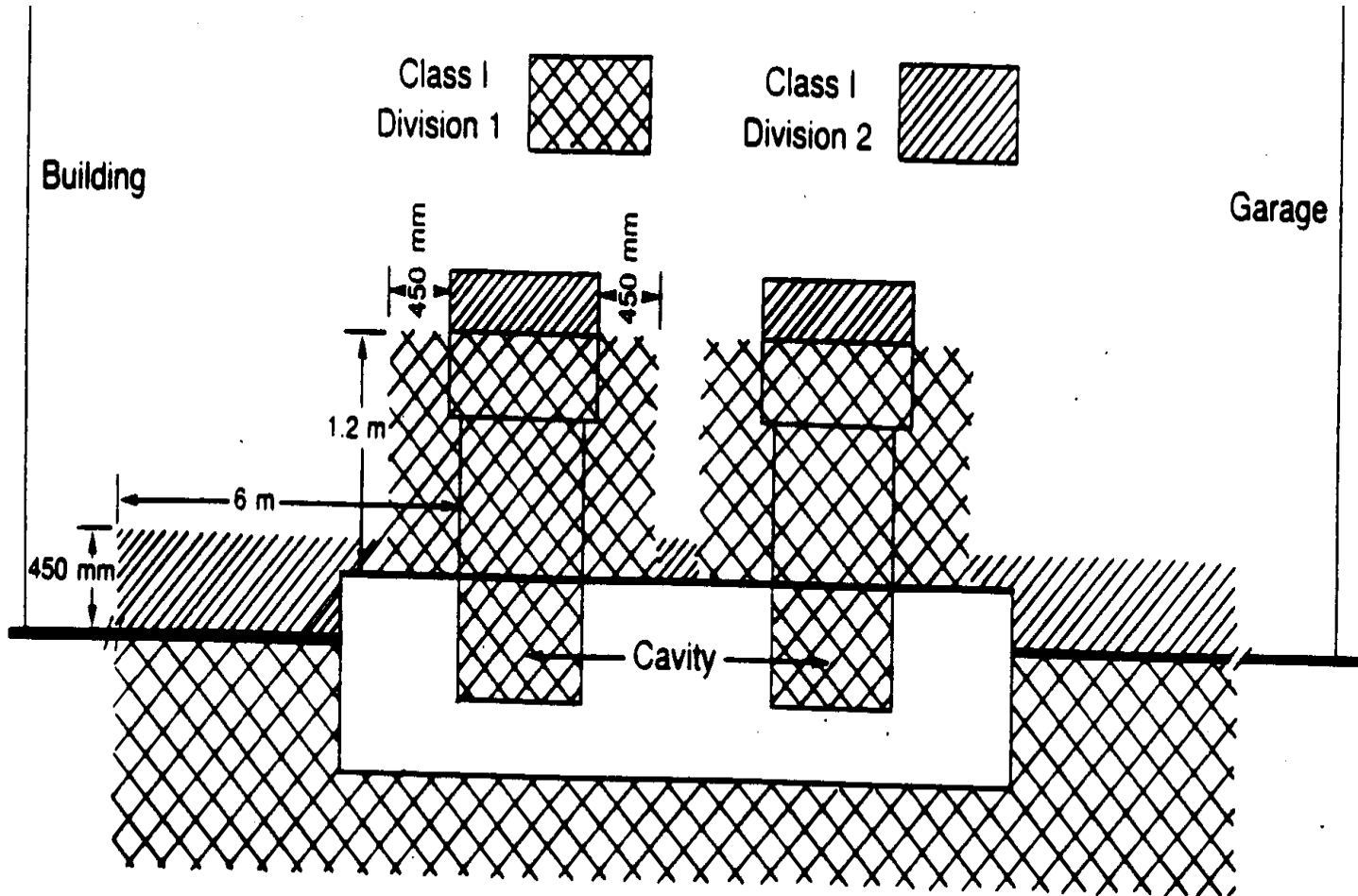


service station hazardous zone CLASS I, DIVISION 2

Reference: National Electrical Code, NFPA 70 Class I, division 2 (including division 1, where vapors **COULD be present**).
20 feet (6 meters) from the dispenser
15 feet (4.5 meters) from the tank fill pipe
5 feet (1.5 meters) around the vent



hazardous zone - pumps



Class I, division 1:

Space above the base of the dispenser enclosure up to 4 feet (1.2 meters)

18 inches (450 millimeters) horizontally in all directions from the dispenser.

Class I, division 2:

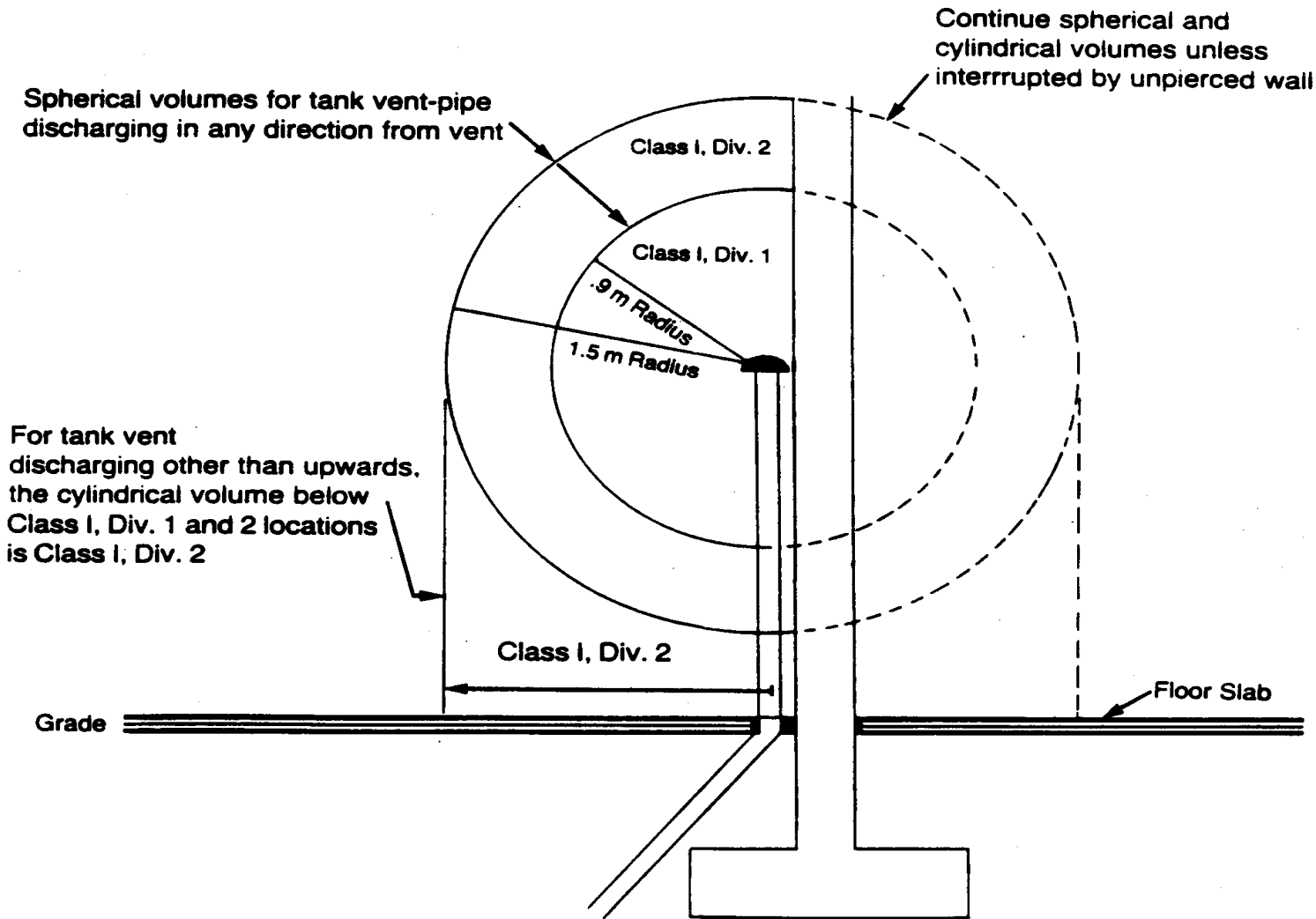
20 feet (6 meters) from the dispenser

18 inches (450 millimeters) from the pavement

At the dispensers in a service station



hazardous zone - vent



Class I, division 1:

A sphere of 3 feet (0.9 meters) radius from top of the vent

Class I, division 2:

A cylinder of 5 feet (1.5 meters) radius around the vent at the pavement level up to the top of the vent.

Around the vent at a service station



gas testing for hot work (cont)

Prior to testing for Hot Work activity:



- Cover all sewers and drains within 15 meters (50 feet) that **may potentially** contain hydrocarbon, or hydrocarbon vapours **with weighted drain cover.**
 - Cover the vents (ensure sufficient safeguards for pressure/vacuum relief if tank vents are covered)
- or
- Redirect the vent exhaust to a safe area, as appropriate.



gas testing for hot work (cont)

Gas-test all of the following locations within 15 meters (50 feet) of where Hot Work will take place:

- Drains
- Vents
- Low spots
- Flange joints
- Valve stems
- Sumps
- Suspect excavations or trenches



Gas-test at grade level in the immediate vicinity of where the Hot Work is to be performed

conduct gas tests

- Only Qualified Gas Testers are authorized to conduct gas tests
- Contractors are required to have their own gas testing equipment
- Test the work area atmosphere for the identified hazards.
- Testing should start in a known safe area and move into the work area to be tested.
- Tests should be done in the following order:
 - Oxygen
 - Flammable gases
 - Toxic vapours



conduct gas tests cont.

- Test in area where flammable or toxic gases/vapours are likely to accumulate.
- Any tests which indicate readings outside the acceptable range should result in the area being cleared of all personnel and the area ventilated until a safe environment is obtained.
- Appropriate PPE must be worn when testing (e.g. respiratory protect required when initially testing inside a confined space such as a tank).
- Any alarm activation on the test instrument should result in an immediate evacuation of all personnel out of the area until the reason for the alarm is determined and corrective measures taken.
- Gas testing on it's own is not a Remote Permitted high risk activity, however will apply to Hot Work, Confined Space entry, Trenching and Excavation which are High risk activities controlled by permits.



typical scenarios for gas testing

The following are some typical examples where gas testing would be required at a facility:

- Before performing Hot Work or entering a Confined Space.
- When responding to a spill of hazardous materials.
- Entering an oily water separator to clean or carry out repairs.
- Sumps, manholes, pits atop underground storage tanks, or any other confined space.
- Trenches, excavations or tank holes 4ft or greater.
- Carrying out welding (or other hot work)
- Inside electrical conduits



Not a complete list



gas testing requirements

- **Initial Gas Testing** - Must take place before (<30 minutes prior) the General Work Permit is issued (time) to determine requirements for entry.
- **Follow up testing** - performed after initial testing at intervals sufficient to ensure that the atmosphere remains safe, whenever work has stopped for 30 minutes or more, whenever operating conditions changes or **at least once every four hours.**
- **Continuous Gas Testing** – Gas tests are continuously monitored, Continuous Gas Testing is required during all confined space entry operations and welding in classified hazardous areas.

Note: This is not an all inclusive list of Gas Testing requirements, just some key items to remember.



permit requirements (cont)

- Only **approved** Permit Writers that have had additional competency training per OSHA / Worksafe BC guidelines, API and contractor assessments completed can sign in the Permit Requestor or Permit Issuer boxes on the Permit forms.
- The workers name must also be on your companies remote permit writer list that are submitted to Chevron, this includes any work which requires permits such as the GWP and Hot Work form.

NOTE: IF ANY OF THE ABOVE ANSWERS ARE "NO", DO NOT PROCEED UNTIL CORRECTED			
Permit Requester (signature):		Permit Issuer (signature):	
Time Issued:	am/pm	Date:	Associated General Work Permit No.

- See Remote Permit Power Point for additional General Contractor guidelines and requirements for certifying Sub Contractors to Remote Permit.



key definitions

The following general definitions apply to Gas Testing:

- **Bump Test** (Response Check) – A functional check on test instruments prior to use. Bump tests may also be conducted after conducting gas tests, in addition to and prior to use test, to confirm the functionality of the instrument. If the instrument does not respond correctly it must be Field Calibrated. Test must be documented
- **Combustible Gas Indicators** – Meters using a filament heated or coated with a catalyst that reacts with flammable vapour. Typical instruments using the combustible gas indicator method include instruments normally known as “LFL/LEL explosion meters/vapour testers”



key definitions cont.

- **Continuous Gas Testing** – A process whereby the required gas tests are continuously monitored. Continuous gas testing is normally required where there is a high likelihood of changing gas concentrations and/or there is a high risk to workers if the gas concentration changes unexpectedly
- **Calibration** – A periodic physical test of gas testing equipment to ensure that the testing element sensors and alarms are working within prescribed limits. Field calibration tests differ from Bump Tests in that the instrument is reset in accordance with the manufacturer guidelines, to the “optimum” reading as opposed to ensuring the instrument is within the calibration range. Field calibration, at a minimum must be performed monthly to ensure the instrument is not in need of repair and will function correctly when needed. Test must be documented.
Instrument ‘self tests’ does not constitute calibration



key definitions cont.

- **Follow Up Testing** – Performed after initial testing at intervals sufficient to ensure that the atmosphere remains safe for the work being performed. Follow-up tests must be performed whenever work has been stopped for more than 30 minutes, whenever operating conditions change, or at least every four hours
- **Gas Testing** – Use of portable detection equipment to determine levels of oxygen and flammable or toxic vapours and gases



key definitions cont.

- **Hazardous Atmosphere** – An atmosphere that expose employees to the risk of death, incapacitation, impaired ability to self-rescue, injury, or acute or chronic illness. Caused by any of the following:
 - Flammable gas, vapour, or mist in excess of 5% of its lower flammable limit (LEL)
 - Atmospheric oxygen concentration below 19.5% or above 23%
 - Atmospheric concentration of any substance that could result in employee exposure in excess of its dose or permissible exposure limit, e.g. benzene, hydrogen sulphide
 - Any other atmospheric condition immediately dangerous to life or health



key definitions cont.

- **Initial Gas Testing** – First gas test taken prior to the beginning of work to determine:

- Requirements for entry into a space
- If the space is safe for hot work



- **LFL/LEL Explosion Meter** – An instrument used to measure in percent of the lower flammable limit (LFL) or explosive limit (LEL) of a flammable substance
- **Lower Flammable Limit** – The lowest mixture of hydrocarbon vapour and air that will support combustion. Typically indicated on gas testing equipment as “100%”. Sometimes referred to as “LEL” or “lower explosive limit”



key definitions cont.

- **Oxygen Monitor** – A device containing an electrochemical sensor that detects oxygen and is used for measuring the percentage of atmospheric oxygen
- **Permissible Exposure Limit (PEL)** – An exposure limit to a chemical, which may be either a:
 - Time weighted average limit (e.g. TWA or STEL)
 - Maximum concentration exposure limit (e.g. Ceiling)
- **Qualified Gas Tester** – A person who has been trained in the use of portable gas testing equipment and has successfully demonstrated its use in the field. Must be trained in gas detection principles and able to recognize hazards inherent in hot work and confined space entry. Only qualified gas testers are permitted to conduct gas tests.



key definitions cont.

- **Safe Atmosphere** – An atmosphere that meets all the following requirements:
 - Is safe for a person to work in without wearing supplied air respiratory protection i.e. no toxic or hazardous vapours and sufficient oxygen
 - Where no flammable vapours are detected within 15 meters (50 feet) of a site where hot work will be performed

Safe



gas testing – additional information

For further instructions and additional information for Gas Testing please refer to:

- Gas Detection Safety Bulletin
- Your companies operating procedures and gas testing equipment manufacture's Owner's Manual and Operating Instructions;
- Your Company's Safety Officer
- The Contractor Safety Orientation material
- OSHA/WorkSafe BC
- API

