

SAFE TRANSPORTATION OF LIQUID FUELS AT SEA GAS AND FLAME DETECTION FOR TOXIC AND FLAMMABLE HAZARDS



Safety signage on board ship

The modern maritime sector relies on gas and flame detection for safe operations. Ammonia, Methanol, LNG, LPG, crude oil, and refined products tankers carry thousands of tonnes of flammable, volatile chemicals, and hydrocarbons daily. These cargoes are all flammable and several are toxic. It pays to review the best practices, codes and regulations for gas and flame detection.



Bunkering operations

Toxic and flammable gas and flame detection

Toxic gases can be present in many maritime applications. Hydrogen sulphide (H₂S) is commonly associated with hydrocarbon processing and gas detection of H₂S would be required on a floating processing, storage, and offloading ship (FPSO) for liquefied natural gas production.

Some maritime gas detection requirements are obvious. Others need a detailed understanding of the potential hazards and appropriate gas and flame detection equipment that is required to minimise the risks. For example, H₂S can also be present in many ships since organic matter in wastewater, bilge and ballast water may decompose to release H₂S.

In addition to the offshore maritime applications, shoreside terminals require gas and flame detection. Tank farms are often fitted with open path area monitoring systems that use long range infrared (IR) beams to detect hydrocarbon leaks.

Flame detection is used outdoors as a second line of defence at storage terminals since strong winds can blow leaking gases away from gas detection equipment. Flame detectors



Fire at refinery next to the Port of Santos, April 3th, 2015, Santos, Brazil

can be especially valuable around loading arms on jetties and pumping stations.

Alternative maritime fuels such as methanol and ammonia introduce an additional toxicity hazard. Furthermore, ammonia burns with an inorganic flame which requires specialised flame detection equipment.

Guidance for tankers and terminals

The International Safety Guide for Oil Tankers and Terminals Issue 6, 2020 (ISGOTT) is a comprehensive document covering safety on oil tankers, terminals, and the transfer of product between them. The Guide details hazards associated with crude oil and petroleum cargoes.

It provides information on safety precautions that should be followed in applications, such as:

- i. loading and discharging of cargo;
- ii. inerting the tanks;



Forced ventilation of a confined space on board ship prior to entry

- iii. gas freeing;
- iv. enclosed space entry;
- v. tank washing.

The ISGOTT makes recommendations for gas detection systems in terminals that handle crude oil and products containing toxic components. A risk assessment is advocated to consider the need for detection of hydrocarbon and toxic vapours. Fixed gas detectors are advocated close to higher-risk leak points such as loading arms, transfer pumps and valve manifolds. Toxic gas detectors may need to be installed on the air intakes of pressurised and non-pressurised control rooms.

Various types of sensors are described in the ISGOTT. It confirms that IR sensors have the benefit of not being susceptible to poisoning, since they do not require a chemical reaction to detect gases. Catalytic sensors are commonly used for % LEL measurement, but the ISGOTT points out that they may require more maintenance than IR sensors in addition to being susceptible to poisoning. On the other hand, IR sensors are not able to detect ammonia, hydrogen, and carbon monoxide. Other sensor types, such as electrochemical cells are therefore required.



LNG transfer Elefsina LNG Terminal Greece

The ISGOTT explains that piping gases to a centralised monitoring station from a network of distributed gas samplers can be problematic. This mode of operation can result in condensation of some gases in the pipelines if trace heating is not used. It also incurs a delay in sensing the gases since they must flow through the pipes. The potential for particle accumulation and sensor damage is also a disadvantage.

The ISGOTT states a preference for the use of gas detection systems that have a distributed network of fixed gas detection sensors that monitor gases in situ and transmit electrical signals to a central controller. These systems, it confirms, provide a rapid response and good reliability.

Gas detection equipment must be used to confirm that adequate



LPG tanker

ventilation of the enclosed space has taken place. The atmosphere must have sufficient oxygen, less than 50% of the occupational exposure limit of any toxic gases and the concentration of flammable vapour must be less than 1% of the LEL.

Understanding the risks of H₂S during bunkering and crude transportation

Safety guidance on bunkering operations is provided in the ISGOTT Sixth Edition in chapter 24. Most ships use marine fuel oil or heavy fuel oil as their propulsion fuel. These refined products are derived from crude oil, which generally contains some fraction of hydrogen sulphide.

During refining, sulphur levels are reduced. However, there is always a risk that H₂S gas can be liberated from bunker fuel and care must be taken when opening any hatches over the fuel tank headspace. Use of portable H₂S monitors is advocated in the ISGOTT Guide.

In crude oil tanker operations, the hazards associated with H₂S can be more severe than for bunkering. Section 1.4.6.2 of the ISGOTT Guide reminds crews that a crude oil with 80ppm by weight can yield 7,000 ppm by volume of H₂S in the gas stream leaving the tank vent.

The occupational exposure limit for H₂S is 20ppm by volume. However, the alarm on a portable gas detection unit would generally be set at half of this level. The human nose can detect H₂S at around 1ppm by volume. However, over a prolonged period our noses become immune to the smell, so effective use of gas detection equipment is essential.

IGC (International Code for Ships Carrying Liquefied Gases in Bulk)

The IGC is relevant to LNG and LPG shipping, requirements for fixed / sampling Systems are outlined. The Code states that gas detection equipment shall be installed to monitor the integrity of the cargo containment, cargo handling and ancillary systems. It adds that a permanently installed system of fixed gas detectors with audible and visual alarms shall be fitted in:

- i. all enclosed cargo and cargo machinery spaces (including turret compartments) containing gas piping, gas equipment or gas consumers;
- ii. other enclosed or semi-enclosed spaces where cargo vapours may accumulate, including inter barrier spaces and hold spaces for independent tanks other than Type C tanks;
- iii. airlocks;
- iv. spaces in gas-fired internal combustion engines;
- v. ventilation hoods and gas ducts;
- vi. cooling/heating circuits;



Product transfer at refined products and crude terminal

- vii. inert gas generator supply headers;
- viii. motor rooms for cargo handling machinery.

In Section 13.6.3, the IGC confirms that gas detection equipment shall be designed, installed, and tested in accordance with recognized standards and shall be suitable for the cargoes to be carried. Section 13.6.19 confirms that every ship shall be provided with at least two sets of portable gas detection equipment that meet the requirement of 13.6.3 or an acceptable national or international standard. Section 13.6.20 explains that a suitable instrument for the measurement of oxygen levels in inert atmospheres should be provided.

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