Liquefied natural gas (LNG) is a generic name for liquefied hydrocarbon gas composed primarily of methane. When natural gas is cooled to approximately -260°F, it condenses to a liquid. This liquid takes up about 1/600th the volume of flammable natural gas vapor, and weighs less than one-half that of water. Natural gas is odorless, colorless, non-corrosive, and non-toxic. The LNG liquefaction process uses vapor compression and refrigeration to lower the gas temperature to roughly -260°F. Typical “mixed refrigerant liquid” processes use a four-component refrigerant that is compressed by a turbine compressor, cooled by passing through a condenser, and flashed to a lower pressure to provide the refrigeration necessary to liquefy the gas. Large liquefaction systems are capable of liquefying up to 5 million cubic feet of gas per day.

Liquefied petroleum gas (LPG), sometimes called propane, is often confused with LNG and vice versa. The differences are significant. LPG is composed primarily of propane (above 95%) and smaller quantities of butane. LPG can be stored as a liquid in tanks by applying pressure alone. LPG is often used for residential heating and BBQ gas grills. LPG also has been used as fuel in light duty vehicles for many years. Compressed natural gas (CNG) is natural gas pressurized and stored in welding bottle-like tanks at pressures up to 3,600 psi. Typically, it is the same composition as the local "pipeline" gas, with some of the water removed.

The distinctive odor of these gases is artificially produced by the addition of sulfurous mercaptan compounds, but must be removed from LNG before liquefaction and storage.

LPG and LNG are typically used in the vapor phase as a combustion fuel for heating systems, and many different industrial processes and applications. Storage facilities for LNG/LPG such as peak shaving plants utilize transport loading terminals, storage tanks and spheres, liquefaction processes, vaporization systems, and pipeline gas distribution compressors. Each of these areas generates fire risks, and the possibility of accidental gas leakage that could lead to a fire or explosion. Therefore, it is important to provide built-in, automatic gas leak and fire monitoring of each area, and to provide mitigating action should an abnormal hazardous situation arise.
Hazards

The most frequent LPG/LNG transport hazard occurs when an uninsulated, flammable, liquefied gas tank is involved in a fire caused by a collision or accident, and the tank walls (exposed at low liquid levels) become overheated and rupture. The resulting BLEVE (boiling liquid expanding vapor explosion) event is typically violent, and often causes serious injury to people and significant damage to property. Transport loading/unloading lanes should be protected by combustible gas detectors, optical flame detectors and fire suppression systems to prevent a gas leak, spill fire, or BLEVE from developing into a plant-wide catastrophe. Fixed LPG/LNG storage tanks also provide the potential for BLEVE events, and smaller external gas leaks that can result in fire. Typical LNG tanks have six feet of insulation between the inner and outer walls, and are designed for 1.0 psi service. A small amount of LNG is boiled off each day due to heat entering the liquid, and vapors are usually recompressed and fed into the pipeline distribution system or flared. The tank valve trains, regulators, pumps, and flange connections all provide likely points of gas leakage and accidental ignition. Combustible gas and optical flame detectors are highly recommended to ensure fast response to a gas leak and/or fire in these areas.

Accidental tank overpressure is a common cause of tank leakage, and is usually caused by overfilling, or from expansion of the gas caused by a significant increase in vessel temperature. Other causes of LNG sphere leaks and fires include leaking pumps, glands, and failure of relief vents and valves. Human failures have also caused several catastrophic incidents involving gas storage spheres that could have been prevented by installing automatic safety systems including pressure relief valves, explosion panels, and automatic gas and optical fire detection systems.
Application Bulletin

LNG / LPG Facilities

NFPA 58 entitled “Storage and handling of Liquefied Petroleum Gases” requires fire protection where the installation has storage containers with an aggregate capacity of more than 4000 gallons (15.1 m³) subject to exposure from a single fire. Large storage tanks can often contain up to 12 million gallons of liquefied gas, or the equivalent of 1 billion cubic feet of natural gas. The Eclipse infrared open-path gas detection system is recommended for large area monitoring of LNG sphere storage tank areas, and Infrared or combination Ultraviolet/Infrared flame detectors are recommended for high risk fire ignition area monitoring.

Vaporization processes draw the LNG gas from the tank, raise the pressure to approximately 220 psig, and pass the liquid through a heat exchanger where it is vaporized at 70°F, and then distributed for use. Typical vaporizer capacity can be up to 72 million cubic feet of gas per day. This is a high-risk process area due to the presence of heat, pressure, and the sheer volume of flammable material. A liquid spill or gas leak fire can be disastrous if the fire reaches uncontrollable proportions and the vaporizer contents are released. Another common failure is corrosion leading to gas leakage within the vaporizer heat exchanger, resulting in the natural gas release and fire in the vaporizer stack. This high-risk process area is typically monitored by combustible gas and optical flame detectors, and should be protected by an automatic fire suppression system.

Recommended Fire and Gas Detection Technologies

Infrared-based (IR) combustible gas detectors are recommended for monitoring for LPG/LNG leaks within these areas. A combination of the model OPCL Open Path Eclipse and Pointwatch Eclipse gas detection systems is recommended for early warning, and overall facility protection.

Outdoor LPG/LNG transfer, process, and storage areas are best protected by the Protect•IR X3301 Multispectrum IR flame detector. The Protect•IR provides excellent LPG/LNG flame detection capability and delivers the nuisance alarm rejection capability required to ensure reliable performance.

Total area hazard monitoring and fire suppression systems should be researched and designed early in the planning stage of the facility. Gas leak and fire hazard analysis is necessary to begin this process. The first step in protecting any flammable storage facility is to always identify the specific flammable liquids or gases present within the area to be protected, and the most likely events and conditions that will lead to a gas leak and fire. This is essential for selection of the proper detection technologies, fire suppression and control systems.
Detector Placement Recommendations

Point-type gas sensors should be installed where they will consistently detect any gas or vapor leakage/build-up. Generally the closer the sensor is to the gas leak, the faster the alarm response, although the comparative area monitored also may be smaller depending upon air current patterns. The absolute area or volume effectively protected by a diffusion sensor is difficult to define; Underwriters Laboratories suggests that a diffusion smoke detector can cover a 900-foot square foot or less ceiling space. This could equal a 30-foot by 30-foot square area, or a 17 foot radius circular area. This general spacing recommendation is used by Det-Tronics as a basic guideline for placement of diffusion-based gas detectors, but is subject to change depending upon the specific application and conditions. Always prioritize the high-risk gas leakage and accumulation areas to enable efficient sensor placement.

Open-path infrared gas detection systems provide big-picture information regarding gas cloud release and movement within an industrial plant. Flammable liquid storage facilities often encompass a large physical area, with many potential gas leakage points. When installed properly, the Open Path Eclipse system will provide perimeter monitoring that serves like an optical fence, providing an output from each instrument that shows the total molecular hydrocarbon gas content between the transmitter and receiver modules. Analysis of wind direction along with gas concentration can provide valuable information regarding total plant gas leakage. Used together, point-type and open-path gas detection systems provide the most effective, total facility, gas detection system available.

Should a fire occur, optical flame detectors serve as the final line of defense. They should be installed to provide monitoring of the most likely places where a fire will start, such as pipe connections, valve, pump, or vaporizer leaks. Nearby ignition sources may include turbine compressors, electric motors, or gas burners. Optical flame detectors in high-risk fire ignition areas should be aimed directly at the likely ignition points for maximum sensitivity and speed of response. The benefit of dedicated “ignition point” detectors is that fire detection and suppression will occur as quickly as possible, ideally before the fire reaches uncontrollable proportions.

Most optical IR flame detectors available today process fire signals using a standard measurement of IR energy threshold and flicker rate, or simple ratio measurements. This precludes their use in most LNG applications, the cold gas cloud and metal surfaces during a gas release will cause these detectors to become desensitized, or even incapable of detecting the fire. The X3301 Protect•IR’s patented sensor sensitivity...
wavelengths and processing algorithms provide fire detection regardless of the background. The advanced signal processing algorithms of the X3301 provide a detector that can detect more fire types, faster, and at substantially longer distances, than any detector available on the market today.

The X3301 is capable of responding to a 30 inch Methane plume fire in under 0.5 seconds at 50 feet, and under 3 seconds at 100 feet. The advancement in coverage of the X3301 is unequalled, at 100 feet on axis and 100 feet off axis, by any other technology.

Without a built-in test of the flame detector’s optical integrity, it is impossible for the user to know that detection capabilities are not compromised by possible settling of blinding compounds on the detector optical surface. The X3301 offers an important advantage due to the design of the optics test system. By using a calibrated optical integrity test, the device is able to differentiate between sensitivity loss due to optical contamination, or a general fault or failure. The X3301 provides different current signal output levels to differentiate these fault conditions.

As there may be one or more suitable detector location schemes for protecting an application, and different layout options should be evaluated, the merits of each design should be considered before selecting a location and coverage scheme. A flame detector sighting/laser-aiming device is recommended to confirm proper detector location, alignment, and aim point.

Every facility that handles LNG or LPG should provide built-in, automatic gas leak and fire monitoring to protect the operators and the equipment. Det-Tronics gas detectors, optical flame detectors, fire suppression and hazard monitoring systems are recommended for total life safety and LPG/LNG facility protection.