



UNITED STATES COAST GUARD

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MARINE SAFETY ALERT

Inspections and Compliance Directorate

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Safety Alert 3-15

LIQUEFIED PETROLEUM GAS (LPG) Cargo and Hydrate Handling Risks

This Safety Alert serves as a reminder to all Gas Carrier owners and operators of the importance of ensuring all personnel follow approved Safety Management System cargo handling procedures and industry best practices. It recommends that owner operators ensure all shipboard personnel associated with the handling of cargo are familiar with all existing procedures to reduce casualty risks. Further, it recommends that when shipboard personnel identify cargo or safety concerns that they inform facility personnel prior to commencing loading or immediately after an issue is noted during cargo transfers.

Recently, the Coast Guard investigated a fire that occurred in a cargo compressor room onboard a foreign flagged Liquefied Petroleum Gas (LPG) Carrier. Investigators suspect that unsafe cargo handling procedures associated with manual draining of hydrates from the drain line on the outlet of re-liquefaction condensers directly contributed to this casualty. Hydrates are compounds, in the form of crystalline substances, developed from the interaction of water and hydrocarbons at certain pressures and temperatures. They are commonly present in LPG cargoes and must be safely managed throughout the cargo system. Hydrates, if not removed, can result in frozen regulating valves, clogged filters, damaged equipment, and other problems in the related cargo systems.

In the incident under investigation, the LPG being loaded was at a higher temperature than the operator desired for transit. In order to cool the LPG cargo, the gas was re-liquefied to a lower temperature by using the vessel's boil off system. The gas was directed from the tank to a compressor, compressed to a higher pressure, and then condensed back to a liquid at a lower temperature. From the condenser it flowed back to the tank, but first passed through an expansion valve. It was reported that while this system was operating, the piping near the expansion valve began constricting flow due to hydrates freezing. This then caused an increase in system pressure from the expansion valve back via the condenser and to the outlet of the compressor.

Crewmembers reported that a ball valve at a sample point in a condenser outlet piping was opened on occasion to drain the hydrates into a modified bucket. It was also learned that flanges on the outlet piping of the ball valve had



been removed and left off. Investigators were told that the Cargo Engineer regularly made rounds to manually drain the hydrates to the bucket in order to prevent the freezing of the expansion valve. However, no buckets were found and significant accumulations of ice were noted in the bilge areas below the same sample point for two of the three liquid line drains.

Whether or not buckets were used to capture the hydrates, along with escaping liquid propane, and then later allowed to boil off as stated by the crew, or if the drains were left cracked on or just leaking, as they were found, may never be exactly determined. However, the ice formation in the bilge seems to indicate the latter was the more prevalent condition. Regardless of either initial condition, a hazardous flammable atmosphere developed. With the doors of the compressor room clearly labeled to be kept closed, but latched open, it is likely that proper air flow and volumetric air changes in the space did not occur. It is speculated by crewmembers that a fallen flange blank may have provided the initial spark that ignited the gas. A fire subsequently developed and destroyed electrical cabling and gaskets associated with the condenser. It was extinguished quickly by a crewmember who was in the space at the time, using handheld dry chemical extinguishers.

There were also other concerns identified during this investigation. The following additional concerns focus primarily on procedures that existed or were absent prior to the incident: an emergency system left in the manual mode prevented remote activation; senior organizational personnel for the operator and facility were not informed of the hydrate situations; procedures for taking actions when gas alarms sounded were not followed; and gas detection devices were not properly calibrated.

The importance of Safety Management Systems and Operational Manuals to be totally inclusive of all routine vessel processes and procedures cannot be overstated. Although every scenario that involves decision making of officers and crewmembers cannot be documented, it is reasonable to expect that those procedures that are part of day-to-day operations are documented.

As a result of this casualty the Coast Guard **strongly recommends** that:

- Senior shore side operating company personnel provide extensive technical support when a vessel is required to load cargo at higher temperatures and when substantial hydrates quantities are known to be contained within;
- Shipboard Safety Management Systems and Operational Manuals be inclusive of all procedures to be expected and performed onboard. In the incident under investigation a procedure for removal of hydrates was unavailable;
- Such procedures, when they are developed, implemented, and performed should align with industry best practices and all changes to the documented procedures should be vetted through the associated parties for approval ensuring notification takes place as required;
- Routine and frequent training of shipboard officers and crew based on documented procedures for vessels transporting dangerous cargos should take place on a regular basis and cover such topics as;
 - The safety risk of releasing LPG in open and enclosed spaces;
 - Proper methods to acknowledge and investigate gas detection alarms regardless of location; (Including making proper notifications to responsible parties)
 - Ensuring that all ventilation systems are functioning as designed with no conditions hindering its effectiveness such as open doors or obstructions;
 - Methods to inspect and identify leaks throughout the cargo system, and corrective actions to take when leaks are identified;
 - Ways to manage and minimize the negative effects of hydrates throughout the entire cargo system;
 - Methods to reduce static electricity as found in the National Fire Protection Association (NFPA) 77.

LPG Carrier owners and operators are encouraged to contact the Coast Guard regarding hydrate management and other cargo issues. This Safety Alert is provided for informational purposes only and does not relieve any domestic or international safety, operational or material requirement. Questions regarding this Safety Alert should be forwarded to the Coast Guard Office of Commercial Vessel Compliance, Foreign and Offshore Vessel Division (CG-CVC-2) by email at CGCVC@uscg.mil. Port and Facility questions regarding this Safety Alert should be forwarded to the Office of Port and Facility Compliance (CG-FAC) by email at CGFAC@uscg.mil.