CTAC Vessel Cargo Tank Overpressurization Subcommittee
Executive Summary

The Chemical Transportation Advisory Committee (CTAC) identified a need for a standard that can be referred to by industry participants, that addresses cargo tank over-pressurization hazards associated with inerting, padding, purging, and line clearing operations. Both the Coast Guard and industry are concerned that there will continue to be overpressurization incidents in the absence of such a standard. CTAC established the Vessel Cargo Tank Overpressurization Subcommittee to study this issue and report on the following tasks:

1. Review and evaluate current industry practices and procedures involving the introduction of pressurized nitrogen gas from waterfront facilities into a vessel's cargo tanks during inerting, padding, purging, and line clearing operations, and identify the hazards associated with these operations.

2. Provide recommendations for the development of an industry standard to address the prevention of cargo tank overpressurization during inerting, padding, purging, and line clearing operations.

The Subcommittee identified and defined seven operational practices during which cargo tank overpressurization hazards are present:

1. Inerting – The process of introducing an inert gas into an empty cargo tank for the purpose of preventing a flammable / explosive atmosphere from developing within the cargo tank. In the marine industry a cargo tank with an oxygen content of 8% or less is considered an inerted cargo tank. On chemical tankers, the general practice is to use large volumes of compressed nitrogen supplied form shore.

2. Purging – The subcommittee found a difference in the use of this term within the oil tanker and chemical tanker industries. The oil industry defines purging in terms of hydrocarbon content (< 2%) in a cargo tank, while the chemical industry defines purging in terms of the oxygen content (< 2% and occasionally < 0.5%) in the tank. In chemical industry practice this operation is similar to inerting, however its purpose is for protecting product quality in addition to safety, due to the wider flammable range of some chemical products.

3. Padding (also know as blanketing) – Filling a cargo tank and associated piping systems (and adjacent spaces when specified) with a liquid, gas, or vapor which separates the cargo from air, and maintaining that condition. In practice, nitrogen is most often added to a tank that has already been filled with cargo. The principal purpose of the pad is to establish a positive pressure on the tank, preventing the ingress of water or air as the tank cools. Either shore or vessel nitrogen maybe used to establish a pad in a cargo tank.

4. Topping Off – Introducing additional inert gas into a tank that is already in the inert condition to prevent ingress of air by maintaining positive pressure in the tank. Nitrogen supplied by the vessel is used for topping up.

5. Drying – Filling a cargo tank and associated piping systems with moisture-free gas or vapor having a dew point of –40^{o}C or below at atmospheric pressure, and maintaining that condition. Very pure nitrogen supplied from shore is used for drying.

6. Line clearing (also called pigging and blowing lines) – A practice in which compressed air or inert gas is used to push or move residual cargo though a line into a tank vessel, shore tank, or special receiving vessel such as a truck. Pigging is a form of line clearing in which an object, known as a "pig", is inserted in the line between the product and compressed gas and forced to move through the line by the resulting pressure differential.

7. Loading form Railcars – Compressed air or inert gas is used to "press out" a product from a connection on top of a railcar to a discharge line at the bottom of the railcar tank. A booster pump may or may not be used during this type of operation.

General hazards associated with current marine industry practices using compressed gases, inattention to sound procedures, and other failings on vessels and shore have had the following consequences:

- Death
- Injury / chemical exposure
- Release of product in the air and/or water
- Product entering vapor control systems (risk of fire/explosion)
- Damage to equipment
- Structural damage to vessels

Although there have been industrial accidents associated with the use of compressed gases for many years, the increasing trend to conduct closed operations has been accompanied by an increase in the number of such accidents. In the chemical industry, the most common consequence of such accidents has been the release of product. The advent of vapor control regulations for specific products and the increase in customer requests to control vapors for additional products has contributed to incidents in which product has entered vapor control systems. In some cases, vessel tanks have been overpressurized, leading to equipment failure, buckling of bulkheads, and impairment of the structural integrity of the vessels.

The Subcommittee discussed ways to prevent cargo tank overpressurization and agreed to focused on three areas:

1. Mechanical Safeguards
2. Operational Procedures
3. Education

The Subcommittee used the PTP Marine Operations Risk Guide to gather data and evaluate potential solutions. Members of the Subcommittee agreed that all potential solutions should be evaluated based on the following criteria:

- Solution should not release additional unauthorized cargo vapor or have negative effect on the environment.
- Solution should not create additional hazards, but should provide 'failsafe' solutions.
- Economics should be considered. Specifically, the cost to implement the solution and any costs incurred by changing current operations (ie. slowing pace) should be considered.
- Ideally there should be one standard that applies to all operations, which should utilize standard fittings on the vessel and shore.
- Solution should include mechanical safeguards that are effective at controlling **gas** flow rates (not just liquid flow rates).
- The level of difficulty in implementing the solution should be considered.

Analysis and Results

Lack of communication was identified, for each of the practices reviewed, as being a primary contributor to vessel tank overpressurization incidents. It was noted that the pre-transfer conference is the appropriate time for vessel and shore personnel to exchange relevant information concerning each operation that they plan to perform. Key information that should be exchanged during a pre-transfer conference for inerting, padding, purging, line clearing, and railcar transfer operations includes, but is not limited to: roles of personnel, identification of tanks in use, connections, units of measure, maximum volume, maximum pressure, timing, equipment limitations, event sequence, emergency signals and procedures, and anticipated stop time. Many lengthy operations require a shift change in personnel prior to the completion of the operation. It is vitally important that the relieving shift be fully briefed before assuming responsibility for the operation. In addition to discussions at the pre-transfer conference, dock and vessel Persons in Charge (PIC) must discuss all critical operations before they commence.

The act of continuously monitoring each operation as it unfolds was also identified as a key step in preventing vessel tank overpressurization. Specific equipment and events that should be monitored during the various operations include, but are not limited to: tank pressure, valve integrity, P/V valve performance, pig movement, the possibility of "blow-by", regulator settings, and cargo levels in railcars. An adequate number of experienced personnel must be present during these operations to ensure that all of the equipment used

to protect the tank vessel from overpressurization is functioning properly, the system is properly lined up, and proper connections are made.

Recommendations

1. Mechanical Safeguards: Install and/or use pressure gauges, pressure indicators, pressure sensors, gas flow regulators, valves suitable for controlling gas flow, valves suitable for controlling liquid flow, automatic shutdown devices, pigs that seal in the pig trap, orifices that provide flow limitation, alarms, interlocks, sight glasses, phase indicators, and level indicators.

2. Education (training): Ensure all personnel thoroughly understand pre-transfer procedures, hazards of the operations, gas laws, proper use of equipment, how to monitor operations, emergency procedures, how to deal with equipment malfunctions (e.g. freeing a pig that is stuck in the line), and record keeping.

3. Operational safeguards: Ensure that an adequate number of experienced and trained personnel are participating in all operations. Ensure accurate written procedures are available to all involved personnel. The written procedures should be available for all operations that involve the use of high-pressure gas and they should address safety, equipment, and overpressurization hazards.

A detailed list of recommend practices was developed for each operation where hazards were identified.