

An overview of marine vapour control system safety requirements

W. N. Tuttle, P.E. & J. W. Young, P.E., Warner Nicholson Engineering Consultants, P.C., USA

The generation of flammable vapours during cargo transfer into marine vessels presents numerous hazards even without the implementation of vapour control systems. Some of these hazards are: cargo tank overfill, cargo spillage, and fire and/or detonation of the cargo or its vapours.

When vapour control is included, additional hazards can be introduced by the very nature of the vapour containment system. These hazards include, in addition to the ones already listed, over or under pressuring the marine vessel, inclusion of sources of ignition such as vapour conveying equipment, vapour destruction or recovery equipment, etc. The United States Coast Guard (USCG), under the authority of section 183(f) of the United States Clean Air Act, issued regulations in 1990 to ensure the safety of personnel, equipment and operations of a facility Marine Vapour Control Systems (MVCS) which contain and control the emission of vapours emitted from a marine vessel's cargo tanks during the loading of crude oil, gasoline blends, or benzene. In subsequent years further cargoes were included and the control of these was added to the original regulations by USCG policy letters.

At this moment the United States Coast Guard Regulations coupled with the policy letters are the most comprehensive set of safety requirements for MVCS currently being enforced. Numerous countries have either emulated these regulations with the addition of local requirements or have adopted them in whole with the exception of the requirement for USCG Certification of the MVCS. One of the features of the current USCG regulations within the USCG jurisdiction is a third party Certifying Entity (CE) review of the design, installation and operation of the MVCS. Some terminal operators, outside of the USCG jurisdiction, have voluntarily chosen to follow the USCG Regulations and have requested a third party Certifying Entity review of their systems to insure compliance with the safety requirements.

The pertinent USCG Regulations may be found in the Code of Federal Regulations (CFR), 33 CFR Part 154, Subpart E. (For the complete text of these and other regulations please go to <http://www.vaporcontrol.com/links.html> at the bottom of the page click on the desired regulation). These regulations contain the requirements for facility based vapour control systems. In these regulations reference is made to earlier USCG Regulations that deal with the requirements for the marine vessels themselves. For example, 46 CFR Part 39, Subpart D contains the majority of vessel vapour control regulations and the requirements for the vapour collection equipment installed on marine vessels.

Marine vessel requirements

Important areas addressed by 46 CFR Part 39 include:

- Cargo gauging system (§39.20-3)
- Tank ship liquid overfill protection (§39.20-7)
- Vapour overpressure and vacuum protection (§39.20-11)
- High and low vapour pressure protection for tank ships (§39.20-13)
- Operational requirements (§39.30-1)
- Lightering and topping-off operations with vapour balancing (§39.40)
- Personnel training (§39.10-11)



Figure 1. Dual Loading Dock Skid showing the Vapour Hose connection, Pressure-Vacuum Relief Valve, Hand Operated Block Valve, Quick Closing Vapour Valve, Filter and USCG approved Type 1 Detonation Arrestor.

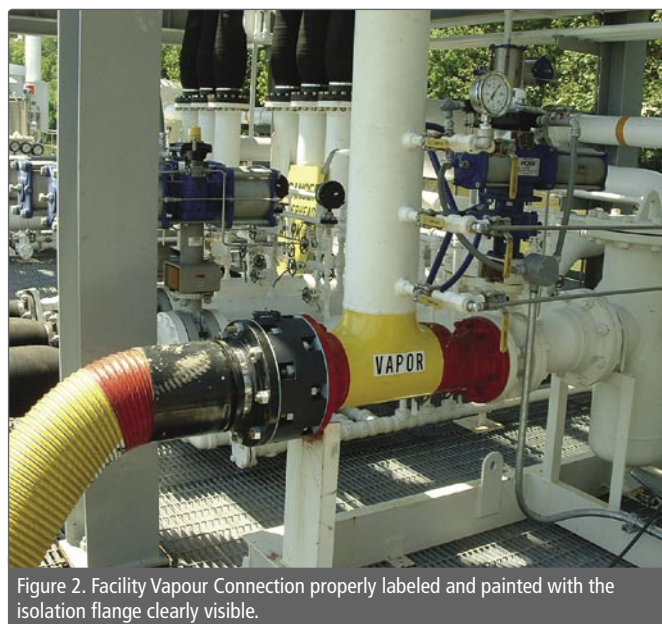


Figure 2. Facility Vapour Connection properly labeled and painted with the isolation flange clearly visible.

Other applicable regulations for vessel MVCS and loading operations are contained in 33 CFR section 155.750 (Oil transfer procedures), 33 CFR section 156.120 (Requirements for transfer), 33 CFR section 165.170 (Equipment tests and inspections), and 46 CFR section 35.35-30 (c) (Declaration of inspection).

Although the regulations permit vapour to be processed on board a marine vessel, in most cases the collected vapours are sent ashore to the facility MVCS for processing. If the vapour processing unit is located on board a marine vessel, it too must meet the requirements of 33 CFR part 154, subpart E to the satisfaction of the Commandant of the Coast Guard in addition to complying with the requirements of 46 CFR part 39.



Figure 3. MVCS End Control Device a Vapour Combustor.

Facility requirements

The typical facility installed MVCS consists of a vapour collection system, an arrangement of piping and hoses, and a vapour processing unit used to recover or destroy the collected vapours. Vapours emitted from a marine vessel's cargo tanks during loading are collected by the marine vessel's vapour collection system and sent to the facility's vapour processing unit for processing.

Methods used to process the collected vapours include recovery (carbon bed absorption, refrigeration, lean oil absorption, etc.), combustion (open or enclosed flares, incinerator), or vapour

balancing (returning the collected vapours to facility storage tank). The majority of existing facility MVCS utilise either vapour destruction or vapour recovery technologies. Very few installations utilise vapour balancing.

In general, major components of most of these MVCS include a vapour destruction unit, or vapour recovery unit; a liquid knock out drum; vapour blowers, detonation arrestors and flame arrestors; oxygen or hydrocarbon analyzers; pressure/vacuum relief valves; and emergency shutoff valves. Vapour destruction equipment requires additional safety measures that include liquid seals, and vapour enriching, inerting, or diluting systems.

The bulk of the requirements for facility MVCS are contained in the regulations of 33 CFR 154, Subpart E. These regulations address the design and operational aspects of facility based MVCS focusing on the following areas:

- Liquid overflow protection (§154.812)
- Overpressure and vacuum protection (§154.814)
- Fire, explosion and detonation protection (§154.820)
- Requirements for inerting, enriching and diluting systems (§154.824)
- Vapour compressors and blowers (§154.826)
- Vapour recovery and vapour destruction systems (§154.828)
- Personnel training and operating requirements (§154.840 and §154.850)
- Design, performance, and testing standards for detonation and flame arrestors (§154 Appendix A and B)
- Additional Requirements for Cargoes Other Than Crude Oil, Gasoline, and Benzene

The MVCS requirements found in 33 and 46 CFR specifically address the transfer of crude oil, gasoline blends or benzene. At the time the regulations were promulgated, 1990, these cargoes were targeted by most Local Environmental Regulatory Agencies in the United States. Since that time, an increasing number of facilities have been required to collect the vapours generated by the transfer of other hazardous cargoes.



Figure 4. Loading Pier with the MVCS end control device, a Vapour Recovery Unit, shown at the end and to the right hand side of the pier.

A system which collects vapours of flammable cargoes other than crude oil, gasoline blends or benzene, must meet the requirements prescribed by the Commandant (G-MSO). These requirements are contained in a Coast Guard policy letter 16703/33-154 of May 5, 1992.

This policy letter addresses the issue of cargo compatibility and the requirement for cargo specific oxygen/hydrocarbon analyzers, alarm and shutdown set-points. It further addresses the fire, explosion and detonation protection requirements for MVCS controlling vapours of cargoes having a closed cup flash point greater than 60° C.

The policy letter also adds special requirements for controlling the vapour of cargoes having a high freezing point, the potential to polymerize, or a vapour growth factor greater than 25 per cent.

- MVCS controlling vapours of high freezing point cargoes must be designed to prevent freezing of vapour or condensate at ambient temperatures.
- MVCS that control vapours of cargoes with the potential to polymerize must be equipped to detect polymer build-up.
- MVCS controlling vapours of high vapour growth factor cargoes must use the vapour growth factor in pressure drops calculations, and when determining the cargo's maximum allowable loading rate.

Since the 1990's more than 50 per cent of certified facility MVCS are certified to collect vapours from cargoes other than crude oil, gasoline blends, or benzene.

Guidelines for tank cleaning facilities

The generation of vapours during the cleaning operation of marine vessel cargo tanks has become an issue in several locations. A number of local regulatory agencies are now requiring vapour control at tank barge cleaning facilities during gas freeing and cargo tank cleaning operations. As a response to this issue, in April 1996 the USCG issued a Navigation and Vessel Inspection Circular (NVIC), No. 1-96 to provide safety guidelines for these facilities. This NVIC, although not currently a regulation, recommends safety standards, based on recommendations from a subcommittee of the Chemical Transportation Advisory Committee (CTAC) on MVCS, for the design and operation of a MVCS at tank barge cleaning facilities during gas-freeing and tank cleaning operations. For the most part, the guidelines follow the requirements in the 33 CFR 154, Subpart E regulations because the dangers of handling flammable vapours are essentially the same.

ABOUT THE AUTHORS AND THE COMPANY

W. Nicholson Tuttle, P.E. holds a Bachelor of Science degree in Chemical Engineering and has been involved in pollution control engineering, design, and application for thirty-nine years. During the past twenty-seven years, he has focused his efforts primarily in the area of air pollution control, especially in activated carbon based vapour recovery systems and combustion type vapour destruction systems. He is the inventor or co-inventor of four patents for vapour control technology.

Mr. Tuttle has authored a number of papers dealing with the subject of volatile organic compound vapour control. He has made presentations to technical trade groups, industrial organisations, and to over thirty regulatory agencies in Africa, Asia, Europe, and North America. He has also been involved with the training of numerous field service and engineering personnel regarding air pollution control rules, regulations, technology and process theory. In the late 1980's Mr. Tuttle was a member of the Chemical Transport Advisory Committee (CTAC) subcommittee that drafted the current USCG Regulations for MVCS.

Jon W. Young holds a Bachelor of Science degree in Chemical Engineering and has twenty-seven years experience in the design, manufacture and service of air pollution control equipment, fired process heaters, flare systems and heat recovery equipment. He has designed and conducted training programs that have been attended by engineers and field personnel on the emission requirements, regulations, trouble-shooting, safety, operation and maintenance of vapour recovery and vapour destruction systems in North America, Europe, Asia and the Middle East.

In addition to his extensive field experience, Mr. Young has written and presented numerous papers to trade organisations and professional societies. He has participated with the US EPA, other national and local air regulatory boards, US Coast Guard Chemical Transport Advisory Committee (CTAC) subcommittee, and local fire and safety authorities in the development of new rules, permit applications, data interpretation and penalty mitigation.

Warner Nicholson Engineering Consultants, P.C. was founded in 1998 in the state of Oklahoma, USA, as a Professional Corporation. The company has unique capabilities for providing engineering services related to the control of air pollutants generated by the handling, loading, off-loading, transportation, and storage of volatile or hazardous organic liquids, including troubleshooting, start-up, engineering and design.

In 1999, WNEC became a United States Coast Guard Third Party Certifying Entity (CE) and since that time have been involved in numerous Certification projects including Vapour Recovery, Vapour Destruction, Vapour Balance and Vapour Destruction with heat recovery. Additionally WNEC has performed marine vapour control system reviews and inspection of non-US based terminals.

ENQUIRIES

Warner Nicholson Engineering Consultants, P.C.
Oklahoma
USA

Tel: +1 (918) 495 0609

Fax: +1 (866) 482 1879

Emails: ntuttle@vaporcontrol.com
jyoung@vaporcontrol.com

Website: www.vaporcontrol.com