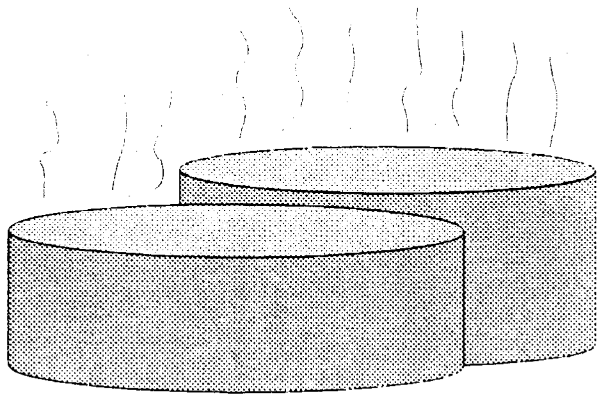
SUPPORTING DOCUMENT

for

Environmental Guidelines for Controlling Emissions of Volatile Organic Compounds from Aboveground Storage Tanks

CCME - EPC - B7E



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2.2.2.3 Chemical Industry

No detailed data on the tanks in the chemical industry sector is currently available to Environment Canada. However a survey of 14 chemical plants in Canada for the year 1988 estimated the VOC emissions from VOL storage to be 0.5 kt (Environment Canada, 1990b).

2.2.3 Emissions Sources

Emissions of VOCs from tanks come from evaporation losses of the stored VOL. There are two types of losses: standing losses and working losses. Standing losses are primarily dependent on the surface area of the VOL exposed to the atmosphere and the variation in ambient temperature; working losses are primarily dependent on the variation of the height of the stored liquid, which is usually associated with the throughput of the tank. The change in liquid height expels vapours or draws in air ("*breathing*" losses), and also wets the tank wall with liquid which subsequently evaporates. Both types of losses vary with the ambient temperature and the vapour pressure of the VOL.

The American Petroleum Institute (API) and the U.S. Environmental Protection Agency (EPA) have both modelled the losses from tanks with and without a floating roof. Both models are based on simple formulae which use emission factors derived from experimental data. These models primarily differ in the emission factors that are used.

The latest model is called TANKS (version 2.0), which was developed by Midwest Research Institute for the EPA and was released in September 1993 (EPA, 1993a). This model was based on the latest emission factors, as compiled in an EPA document (EPA, 1993b). Environment Canada undertook a random verification of the Levelton emission estimates (Environment Canada, 1991) with the TANKS (version 2.0) model. The results indicated that the Levelton emission estimates for individual tanks were generally similar to those computed by the TANKS model for the same set of tanks, with some differences noted for the tanks that emit large quantities of VOCs (TABLE 2.6).

2.2.4 Vapour Control Devices

2.2.4.1 Floating Roofs

A floating roof is a structure that floats upon and is supported by the surface of a stored liquid for the purpose of limiting the losses of vapours to the atmosphere. Floating roofs have to follow the movement of the liquid to be effective, and therefore can only be installed in vertical tanks. Floating roofs are commonly used throughout the petroleum industry, because they are economically efficient in larger tanks storing VOLs -- the prevention of liquid evaporation pays for the floating roof.

(*) The seals of the floating roof are not designed to contain pressurized vapour; therefore, they are not effective in containing vapours from boiling liquids. In addition, boiling liquids have the potential of forming large vapour bubbles which can damage or even sink a floating roof. For these reasons, floating roofs will not function satisfactorily for VOLs that have vapour pressures which exceed 76 kPa (measured at 70 °F or 21.1 °C). → 76kPa = 11 PSI

In small tanks, floating roofs become impractical to use. The ratio of the roof's perimeter area to the total surface area becomes large and the efficiency of the roof declines significantly. At the same time, some roof designs experience buoyancy problems caused by the increase in the ratio of the roof's weight to the roof's surface area. Finally, small roofs have a greater tendency to bind against the tank wall due to their lower weight and greater relative rigidity. This binding may make the roof inoperable or even damage it. In practice, roof diameters must be greater than 3 to 4 m.

There are two forms of floating roofs: external floating roofs (EFRs) where the floating roof acts as the roof of the tank, and internal floating roofs (IFRs) where the floating roof is inside a tank that has a permanent, fixed roof. Generally, larger tanks have EFRs and smaller tanks have IFRs, although there are many exceptions. EFRs are almost always of steel construction, while IFRs are made from steel, aluminum, or low-density polymers sealed between two thin, impermeable, metallic layers. EFRs come in three general types of construction: pan, pontoon and double deck. IFRs come in two general types of construction: full-contact (with the liquid) and non-contact (where the roof is supported above the liquid by pontoons).

Floating roofs must have one or more seals to cover the annular space between the floating roof and the tank wall. These seals are grouped as (e.g., EPA, 1992a):

- vapour-mounted seals -- the lower (or primary) seal is located above the liquid surface,
- liquid-mounted seals -- the lower seal is fully in contact with the liquid, or
- mechanical-shoe seal -- a curved metal sheet held vertically against the tank wall by springs, weighted levers or other means.

Secondary seals may be added above the primary seal to further reduce the emissions from the tank. There are also seals to cover holes in the floating roof, such as holes for the gauge pole or access holes. Various seals and seal configurations are illustrated control device installed are to be subjected to the inspection and record keeping requirements one year after the publication of the guidelines by the CCME. It was felt that a company that has gone to the expense of installing a vapour control device (usually because it made economic sense) should be provided with minimum monitoring requirements.

3.3 Requirements

Because of the difficulty of measuring emissions from this type of source, a maximum allowable emission rate cannot be assigned (although estimates of emissions from a tank can be computed using the TANKS model. The guidelines, therefore, usually specify technology standards instead of performance standards.

Most jurisdictions define tank size in terms of capacity, however, in response to an industry request, the task force defined tank size in terms of diameter for vertical tanks. The rationale for the request was that floating roofs (the least expensive vapour control device for vertical tanks) are defined and priced in terms of tank diameter. Furthermore, there are tall, narrow tanks that may be above a capacity cut-off but be too narrow for a floating roof to be installed. A floating roof is generally unstable if its diameter is less than 3-4 metres (refer to SECTION 2.2.4.1 of this document). FIGURE 3.1 shows the relationship between tank capacity and tank diameter, at least as it occurs in the Canadian downstream petroleum sector.

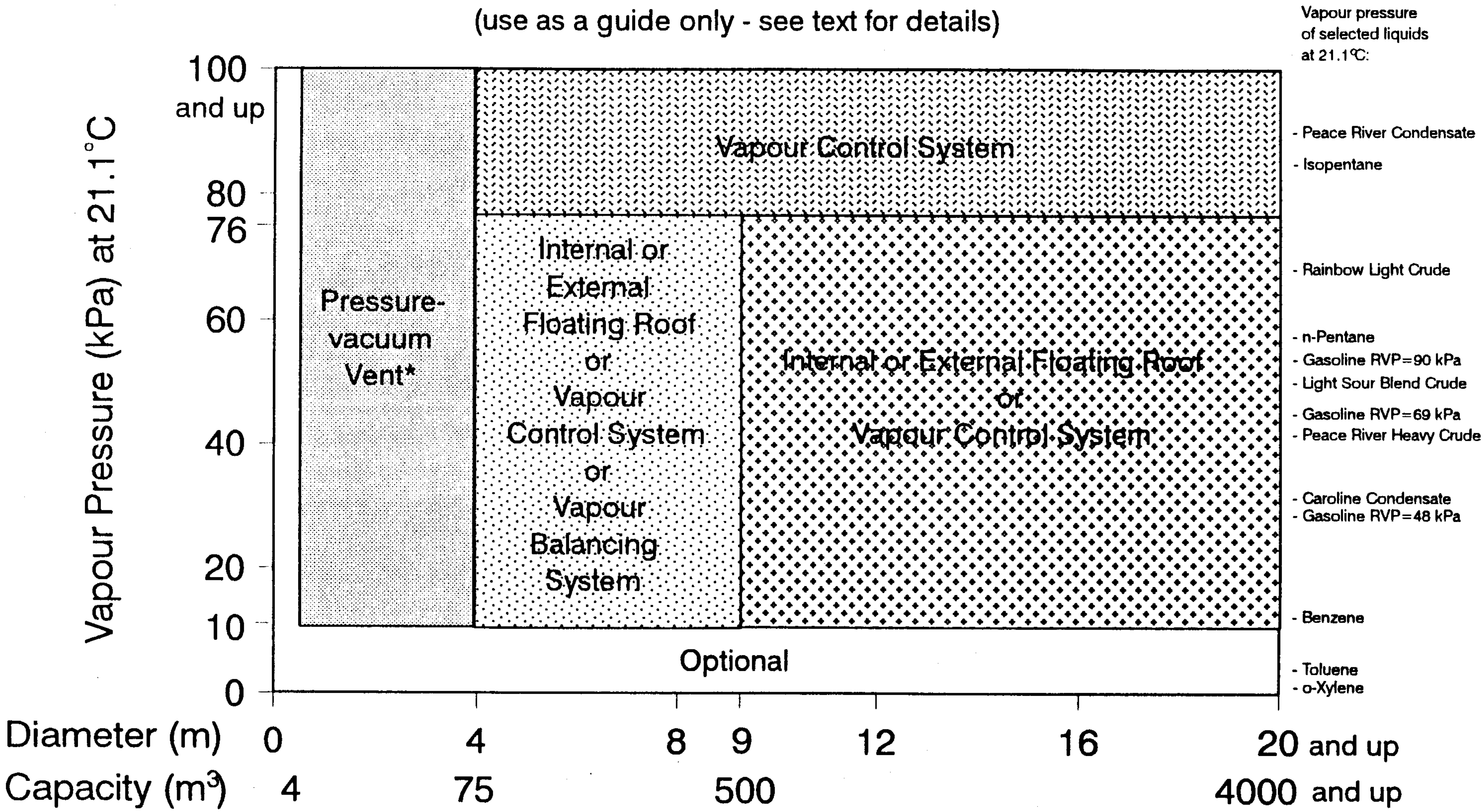
The requirement for a pressure-vacuum vent, provided that the tank can safely withstand the pressure, is an inexpensive requirement for the smaller tanks. Tanks with better vapour control devices are exempt from having to have a pressure-vacuum vent.

PARAGRAPH 4.1.1: The 4 m^3 cut-off and the 10 kPa cut-off were discussed above in SECTION 3.1. The 76 kPa cut-off for the vapour pressure (at 21.1 °C) is approximately equivalent to the most volatile gasoline allowed in Canada (RVP = 107 kPa). This value is also found in the Montreal by-law and almost all U.S. regulations. Liquids with higher vapour pressures are too volatile for a floating roof to work (refer to SECTION ~~2.4.1.1~~ 2.2.4.1).

PARAGRAPH 4.1.2: The 4.0 metre cut-off for tank diameter was based on the cost effectiveness and the industry-wide cost of installing a floating roof (see TABLE 2.7). For tanks with diameters of 4.0-4.5 metres the cost effectiveness is less than $2000 per tonne of VOC emission reduction, while for tanks with diameters of 3.5-4.0 metres the cost effectiveness is approximately $12,000 per tonne. The total industry-wide cost for tanks with diameters of 4.0-4.5 metres is approximately $260,000, while for tanks with diameters of 3.5-4.0 metres the cost is approximately $18 million (primarily because of the larger number of tanks involved).

Figure 2.15: CCME GUIDELINES - 1995
New and Existing Tanks Storing Volatile Organic Liquids

(use as a guide only - see text for details)



Notes: Vertical tank requirements are defined in terms of tank diameter.

Non-vertical tank requirements are defined in terms of tank capacity.

Existing fixed roof tanks must meet the requirements when degassed or by Dec. 31, 2004, which ever is earliest.

All tanks with capacities > 4 m^3 require a submerged fill pipe.

Future toxics considerations may make requirements more stringent.

[*] Exemption: if tank has a floating roof, a vapour control system, or vapour balancing system.