ACAPMA Best Practice Guidelines

Vapour recovery systems for fuel retail outlets

2017 Version
About this document

This document is one in a series of Best Practice Guidelines that have been prepared by the Australasian Convenience and Petroleum Marketers Association (ACAPMA) to assist fuel retailers with the management of their retail fuel sites.

The material provided in this document is not of a detailed technical nature intended for suppliers of equipment and services to the fuel retail industry in Australia - as much of this information is already detailed in relevant Australian Standards and Legislative Guidelines.

Rather, the information contained in this document is of a general nature and is intended to provide a Plain English summary of the best practice processes that fuel operators should consider with respect to the ongoing management of their retail fuel sites (i.e. service stations).

Fuel retailers seeking to information in relation to the design and/or alteration of service station infrastructure are strongly advised to secure the services of:

a) a suitably qualified UPSS designer be engaged to assess the existing site infrastructure and design a solution that is best suited to the existing infrastructure

b) a qualified petroleum services contractor for installation of VR equipment at a site.

Details of potential consultants and contractors for the design and installation of a VR system can be obtained by visiting www.acapma.com.au or calling the ACAPMA Secretariat on 1300 160 270.
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1. Scope of consideration

This Guideline has been developed to provide guidance with respect to the management (i.e. installation, commissioning, monitoring and maintenance) of Vapour Recovery Systems at fuel retail outlets in Australia. The scope of this Guideline extends to:

- An overview of Vapour Recovery (VR) practices and regulations in Australia
- Description of the key components of VR (Stage 1) and VR (Stage 2) Systems
- A description of key commercial and operational considerations
- System maintenance and monitoring

Importantly, this Guideline is not intended to provide detailed guidance with respect to the design and installation of Vapour Recovery systems. (These systems are solely designed to capture reactive vapours from petrol and petrol blends with a view to reducing the precursors to the formation of photochemical smog, which is more noticeable in summer months)

Rather, the purpose of this Guideline is to provide service station operators with guidance on the factors that should be considered with respect to the management of Vapour Recovery systems at fuel retail outlets in Australia.

More detailed design information in this regard should be sourced from the relevant Australian Standards (as interpreted by a suitably qualified petroleum services contractor).

Additional guidance can be found in the NSW Standards and Best Practice Guidelines for Vapour Recovery at Petrol Stations (refer: http://www.epa.nsw.gov.au/resources/air/standards-best-practice-guidelines-vapour-recovery-petrol-service-stations-170157.pdf) but it should be noted that these Guidelines have been specifically developed to satisfy the requirements of NSW Vapour Recovery Legislation (i.e. elements of this Guideline are not necessarily reflective of Industry Best Practice when considered from a national perspective)
2. Overview

2.1 Sources of petrol vapours

Petrol gives off vapour in much the same way as steam is generated when water is boiled. While the rate of formation of petrol vapour varies with temperature, with the rate of vapour formation increasing as the temperature increases, fuel vapours are always present within containment systems that store liquid petrol.

It is important to note that Petrol Vapours are not the same as fuel odours. Hence, Vapour Recovery systems cannot be used to treat all odours from fuel operations.

Petrol vapours can contain Volatile Organic Compounds (VOC’s) such as Benzene, Xylene and Toluene. As the name suggests, these compounds are volatile and react readily with other compounds in air (i.e. Oxides of Nitrogen) under the presence of sunlight to produce the white haze pollution.

These petrol vapours are generally not a problem unless they are released into the atmosphere.

Petrol vapours are generally released into the atmosphere in one of three ways. First, vehicles parked in the sun on warm days will heat up, resulting in evaporative emissions being emitted from the fuel contained in the engine and fuel system of a parked vehicle. These emissions can be controlled by ensuring that vehicles are not parked in direct sunlight (i.e. covered parking stations).

Second, petrol vapours are released into the atmosphere during fuel spill events which can occur during tanker unloading activities at service stations (i.e. larger spills) or during customer refuelling (i.e. smaller spills). Release of vapours arising from these incidents can be minimised by adopting spill containment practices that quickly minimise the associated fire risk and environmental harm (including vapour release).

Third, vapours can be emitted during fuel transfer processes such as tanker unloading at a service station or customer refuelling operations. The release of petrol vapour during these fuel transfer processes can be managed by introducing processes to capture this vapour – referred to as Vapour Recovery.

2.2 Types of Vapour recovery

2.2.1 Vapour Recovery Stage 1

Stage 1 Vapour Recovery (or VR1) involves the capture of vapours emitted during the tanker unloading process only (see Figure 1).

Implementation of VR1 requires the modification of the fuel storage system to create a vacuum so that fuel vapours that exist in the underground storage tanks are drawn into the fuel tanker during the fuel delivery process at the fuel retail outlet.
When the tanker returns to the fuel terminal to reload, the vapours are discharged from the tanker and captured by the fuel terminal storage system for reliquification. This two-stage process effectively ensures the transfer of fuel vapours from the underground storage tanks of fuel retail outlets to fuel terminals and depots, and subsequently returned to its liquid state for resale.

In theory, an effective VR1 system should result in recapture of fuel product that would normally be lost to atmosphere. Unfortunately, real world experience with the operation of these systems has revealed mixed results in this regard.

2.2.2 Vapour Recovery Stage 2

Stage 2 Vapour Recovery (or VR2) involves the capture of vapours from customer refuelling operation on the forecourt of retail outlets (refer to Figure 2).
There are two processes that are used around the world for the recovery of Stage 2 Vapours.

The first involves the modification of the fuel tank of vehicles to allow the vapours to be captured in the vehicles fuel tank to be burned in the engine along with liquid fuel (often referred to as OR/VR). This process has been implemented in countries such as the USA where vehicle design standards have been modified to compel vehicle manufacturers to provide this technology on all vehicles supplied into the market (Note: many of these vehicles are making their way into the Australian market as the Australian new car market moves to 100% imports).

The second process involves the capture of vapours through the pump nozzle via the modification of fuel dispensing infrastructure to create a vacuum that draws the fuel vapour back down into the underground storage tanks at the service station (these vapours are subsequently transferred to the fuel terminal/depot using VR1 processes).

It is worth noting that the installation of a fully operational VR2 system means that the vapours that typically collect in the vicinity of the fill point of the customer’s vehicle are removed (i.e. estimated at 85% efficiency) thereby improving the safety of the customer fill operation overall (That is, the fire risk is substantially reduced to there being a much lower concentration of vapours in air in the vicinity of the customer who is refuelling the vehicle).

2.3 Legal obligations

Fuel retailers are not obligated to install Vapour Recovery infrastructure at their sites unless required to do so by legislation.

Given that Vapour Recovery is only needed to reduce the formation of photochemical smog, it is further suggested that the fuel retail industry is not obligated to install Vapour Recovery infrastructure - unless they are operating in an Australian city that experiences unacceptable exceedences of smog days (as defined by the World Health Organisation).

In Australia, NSW is the only Australian Government that has introduced specific laws requiring the installation of Vapour recovery (Stage 1 and Stage 2) at some service stations. These services stations include those operating in regions in and around the Sydney Metropolitan Region Area, Newcastle Metropolitan Area and Wollongong Metropolitan Area. (See Figure 3).

Some local planning laws and guidelines do, however, require the installation of VR systems as part of the planning and development process. Consequently, fuel retailers should consult with local authorities on any requirements for installation of VR systems prior to developing a new site or refurbishing and existing site.
Further details of the NSW Vapour Recovery Laws, including relevant materials and detailed guidelines, can be sourced by visiting the NSW EPA Website at http://www.epa.nsw.gov.au/air/petrolvapour.htm

It should be noted that some urban Local Governments in other Australian/States and Territories do require Vapour Recovery Stage 1 systems to be installed as part of new site developments (Such requirements are considered to be irrelevant in areas other than major
capital cities or areas where there is a demonstrable problem with the formation of photochemical smog).

It is worth noting that the legal obligations of retail operators who are required to have VR systems in place extend to both the installation and commissioning of VR infrastructure as well as ensuring that these systems remain fully operational during the life of the fuel retail outlet.
3. Key components of Vapour Recovery (VR) systems

The design and operation of Vapour Recovery Systems varies according to whether the system is a VR1 or VR 2 system.

3.1 Vapour Recovery Stage 1 systems (VR1)

VR1 systems are designed to capture the vapours that are released during the tanker unloading process and therefore requires a series of modifications to infrastructure in the vicinity of the fill box, underground fuel lines and vent pipes.

Typically, the installation of a VR1 system at a fuel retail site will require installation of the following components:

- Spill containment enclosures for all tank filling connection points
- Secure seals on tank filling pipes and vapour return pipes to minimise vapour links when the lines are not in use
- Secure seals on any dip hatch openings
- A dedicated underground pipe from the vapour space of the petrol storage tank(s) to the tanker delivery position
- Installation (if not already in place) of couplings on the underground storage tank vapour pipe(s) that automatically close when the tanker hoses (i.e. vapour hoses only) are disconnected
- Installation of vapour and liquid connectors (i.e. hoses) that prevent inadvertent delivery of liquid into the vapour lines
- Submerged fill pipes that terminate at a level that is below the lowest suction (or submerged turbine pump) inlet that is used to deliver fuel to the forecourt dispensers
- Installation of overfill protection to prevent petrol entering the vent or vapour return lines
- When required by Regulation, Installation of an approved Pressure Vacuum (PV) Valve on each vent pipe from the petrol storage tanks (if manifolded, then care should be taken to ensure that petrol vapours do not mix with other fuel products). It is worth noting that there are a variety of PV Valve designs that can be used and fuel retailers should consult with their provider to ensure that the selected design is acceptable under the prevailing Regulations.

The above specifications are merely provided for general information and it is important that both the design and installation of a VR1 system is performed only by a contractor that is appropriately trained and qualified.

Incorrect design, installation (and operation) of a VR1 system may result in vapours simply being transferred from the tanker unloading point to the station vents, as well as producing undesirable pressures (i.e. pressure build-up or vacuum creation) that risks costly damage to fuel system infrastructure.
3.2 Vapour Recovery Stage 2 (VR2)

A VR2 system captures the vapour discharged to atmosphere during the customer refuelling process and returns these vapours to the underground storage tank. The captured vapour may be retained in the underground storage tank (for later transfer using a VR1 process) or can be recovered via the installation of a vapour recovery system.

Fuel retailers are strongly encouraged to seek professional assistance in relation to the selection of a preferred vapour recovery system and should ensure that the selected system is compliant with all relevant VR Regulations.

In Australia, the key components of a VR2 system typically include:

- **Active Vapour Recovery System**: These systems create suction at the interface between the petrol delivery nozzle and the neck of the filler tube on the customer’s vehicle. The level of suction is controlled to match the rate of petrol delivery to avoid returning excess air to the underground storage tank. (Matching the returned vapour to the volume of fuel released is critical to the performance of the VR2 system as returning excess air can raise the pressure in the tank, causing damage to the fuel system. Returning insufficient vapour to the tank can cause a vacuum within the tank vapour space which can also damage the fuel system equipment).

- **Vapour pumps (Central or distributed)**: Active vapour recovery systems can be configured using either a vapour pump in every dispenser (i.e. distributed) or by installing a central vacuum unit that is remote from the driveway flowmeter.

- **Vapour recovery nozzles**: These nozzles are installed in place of conventional refuelling nozzles and provide the interfacing mechanism for capture of vapours from the vehicle’s fuel tank.

- **Coaxial hoses from nozzle back to pump**: These hoses are connected to the vapour recovery nozzles to support the return of vapour from the customer’s fuel tank to the pump – and then through to the underground fuel tanks installed at the site.

- **Vapour return lines (underground)**: New vapour lines need to be installed between the petrol dispenser and the underground petrol storage tanks from transport of vapours from the dispensers to the underground tanks.

- If not installed as part of the VR1 system on site, installation of an approved Pressure Vacuum (PV) Valve on each vent pipe from the petrol storage tanks (if manifolded, then care should be taken to ensure that petrol vapours do not mix with other fuel products).

- **Vapour Processing Units (Optional)**: Where the fuel retailer has elected to return the vapours to liquid fuel, a Vapour processing unit can be installed as part of the VR2 system (i.e. if not installed, the vapour is returned to the underground storage tank for collection by a fuel delivery tanker). While the installation of these units carries an optional cost, these units negate the need to install vapour return lines between the dispenser and the underground storage tanks as well as providing capture of some fuel product for future resale.
More so than VR1 systems, it is critical that these systems are designed and installed by qualified contractors as they involve the creation of vacuums in the fuel system that can potentially damage a fuel system over time if they are not installed and operated correctly.
4. Key commercial and operational considerations

4.1 Economic considerations

The aggregate industry cost of installing Vapour Recovery Systems on the forecourts of the retail outlets in a marketing area is substantial.

Currently, there is no evidence that the magnitude of this cost is exceeded by the value of the net community health benefits that are derived from the installation of these systems (i.e. avoided health costs due to lower incidence of smog days).

It is for this reason that the installation of Vapour Recovery Systems is not recommended for fuel retailers unless:

a) Fuel retailers are legally required to install these systems as a result of a legislative requirement in a given jurisdiction

b) Fuel retailers are operating in a region (i.e. capital city or large Regional Town) where it can be demonstrated that vapours released from retail fuel operations are indirectly contributing to an unacceptably high incidence of smog episodes (as defined by the World Health Organisation).

Where systems are installed, it is in the commercial interests of the fuel retailer to ensure that the installed VR system is effective, compliant and that the system is managed to ensure continuous operation.

This commercial interest is particularly evident where the fuel retailer has incurred the added (and optional) expense of installing Vapour Processing Units to recover fugitive product and convert it back into fuel product.

4.2 Fuel asset considerations

As stated earlier in this guideline, Vapour Recovery systems involve the creation of a vacuum during the filling process and therefore involve physical modification of the pressure systems that were originally installed at the fuel retail site.

Poor design and/or installation of these systems therefore carries a risk that future costly damage may occur to fuel system infrastructure. It is therefore recommended that fuel retailers engage only qualified contractors for the design, installation and commissioning of VR systems at their facilities.

Inadequate maintenance and monitoring of the ongoing operation of VR systems also carries significant risk for fuel retailers. Failed components that go undetected over substantial periods of time can lead to irreparable damage to expensive fuel system components such as underground storage tanks, lines and dispensers.

A variety of available VR monitoring options is further outlined in Section 5 to assist in this area.
It is therefore essential that fuel retailers develop a maintenance regime in consultation with their system provider to ensure that the performance of the system is regularly monitored and that scheduled maintenance - and any maintenance that is identified during the monitoring processes - is performed as required.
5. Key maintenance considerations

5.1 Maintenance plans

Fuel retailers should work with their system providers to develop a maintenance plan to ensure that the installed VR system remains compliant with any regulatory requirements and does not inadvertently cause damage to other fuel system infrastructure.

It should be noted that whilst industry experience with the operation of VR Systems in Australia is relatively new, there is growing concern about the issues created by some components of VR systems have been installed.

In some cases, it has been suggested that failed PV vents (i.e. seized shut) that have gone undetected and have not been rectified have resulted in the creation of vacuums that – together with other factors – are likely to have contributed to catastrophic failures of underground storage tanks.

While this information remains unverified and contestable, there is reason to suggest that it would be prudent to ensure that any maintenance plan that is developed makes provision for regular inspection, testing and maintenance of any PV vents that may be installed.

5.2 System monitoring

The installed VR system should be regularly monitored and inspected to ensure that the system is operationally effective. Three options exist for the monitoring and testing of VR systems, namely:

- **Manual Monitoring systems (Option 1).** While the initial capital outlay of this approach is low, proper implementation of this system requires the development of on-site procedures, regular training of staff, business interruption for testing and inspections plus a comprehensive records management system (i.e. log of tests and maintenance activity). When considered over the life of the system, this cost can be high and carries significant risk of monitoring failure with potential for infrastructure damage and/or prosecution for Regulatory Breach.

- **Automated Monitoring systems (Option 2).** Automated systems are purchased from an appropriate solution provider but still need to be administered by on-site staff who need to be trained in the operation of the system. As with Option 1, staff are required to develop and maintain a comprehensive log of test and maintenance activity. The initial capital outlay is higher than for manual systems, but the training requirement and business cost risks are lower.

- **Outsourced Monitoring systems with SME review and management (Option 3).** This approach involves the outsourcing of the entire monitoring task and records management system to a commercial solution provider. While this approach can be considered more expensive than the other options, it does not require staff to be trained and the business risk of non-compliance is essentially shared with the solution provider.
Where VR Regulation is in place, the fuel retailer should ensure that the nature of the chosen monitoring regime is consistent with the relevant requirements of the Regulation.

5.3 System maintenance records

The fuel retailer is required to maintain complete records of all maintenance (scheduled and unscheduled) performed on the Vapour Recovery system.

Retention of a comprehensive set of records will be valuable in the event of an alleged breach of any regulations that may be in place, as it provides formal evidence of comprehensive management of regulatory obligations. As noted above this can be outsourced to the SME as part of the outsourced fully automated monitoring option.
6. Summary

Vapour recovery systems are installed at service stations to reduce the unintended release of petrol vapours. At high concentrations, these vapours react in atmosphere and sunlight to cause photochemical smog.

The aggregate industry cost of installing Vapour Recovery Systems on the forecourts of the retail outlets in a marketing area is substantial. It is for this reason that the installation of Vapour Recovery Systems is not recommended for fuel retailers unless:

a) Fuel retailers are legally required to install these systems because of a legislative requirement in an individual jurisdiction (i.e. Australian State/Territory or local government area)

b) Fuel retailers are operating in a region (i.e. capital city or large Regional Town) where it can be demonstrated that vapours released from retail fuel operations are indirectly contributing to an unacceptably high incidence of smog episodes (as defined by the World Health Organisation).

Vapour recovery systems involve the modification of pressure and vacuum arrangements for fuel system infrastructure. The consequences of getting these settings wrong can result in catastrophic damage to fuel system infrastructure including underground storage tanks, underground lines and the venting system.

It is therefore recommended that fuel retailers seek advice from qualified petroleum services contractors/consultants before designing and installing a VR system, as well as securing advice on the various options that can be implemented to ensure that the system is regularly monitored and maintained.

Further information about these Guidelines can be obtained by contacting the ACAPMA Secretariat on 1300 160 270 or by emailing communications@acapma.com.au
Some useful references

NSW EPA (2017)

Massachusetts Department of Environmental Protection (Air and Waste)
http://www.mass.gov/eea/docs/dep/air/community/s1wkguid.pdf

Californian Air Resources Board
https://www.arb.ca.gov/vapor/vapor.htm

European Commission