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Best Practice Guidelines

Loss Monitoring of Underground Petroleum Storage Systems (UPSS)

TABLE OF CONTENTS



1. SCOPE OF CONSIDERATION	3
2. OVERVIEW	4
2.1 What is UPSS?	4
2.2 Purpose of UPSS monitoring	4
2.3 Key design considerations	5
2.4 Legal obligations	5
2.5 Commercial considerations	6
3. UPSS MONITORING SYSTEMS	7
3.1 Internal monitoring methods	7
3.1.1 Tank gauging	7
3.1.2 Line detectors (mechanical and electronic)	7
3.1.3 Interstitial monitoring	7
3.2 External monitoring methods	8
3.2.1 Statistical inventory reconciliation (SIR)	8
3.2.2 Observation wells	8
3.2.3 Groundwater monitoring wells	8
3.3 Leak investigations	9
4. LOSS MONITORING PRACTICES	10
4.1 Daily inventory monitoring	10
4.2 Performance of monitoring tasks	10
4.3 Systems maintenance	10
4.4 Record keeping	10
SUMMARY	11
GLOSSARY OF TERMS	12
USEFUL REFERENCES	13

1. SCOPE OF CONSIDERATION



This Guideline has been developed to provide guidance with respect to the monitoring of losses from the operation of underground petroleum storage systems (or UPSS). The scope of this Guideline extends to a discussion of:

- » The legal obligations of all fuel retailers to prevent fuel leaks from UPSS
- » Key legislative and commercial considerations
- » Key design considerations and components of a UPSS loss monitoring system
- » Recommended UPSS loss monitoring and leak investigation practices

Importantly, this Guideline is not intended to provide detailed guidance with respect to the design and installation of underground petroleum storage systems.

Information in this regard should be sourced from the relevant Australian Standards, as interpreted by a suitably qualified petroleum systems designers and/or petroleum services contractor.

2. OVERVIEW



2.1 WHAT IS UPSS?

An underground petroleum storage system comprises all the underground infrastructure that is installed at a retail fuel outlet for the receive, storage and dispensing of fuel to retail customers (see Figure 1).

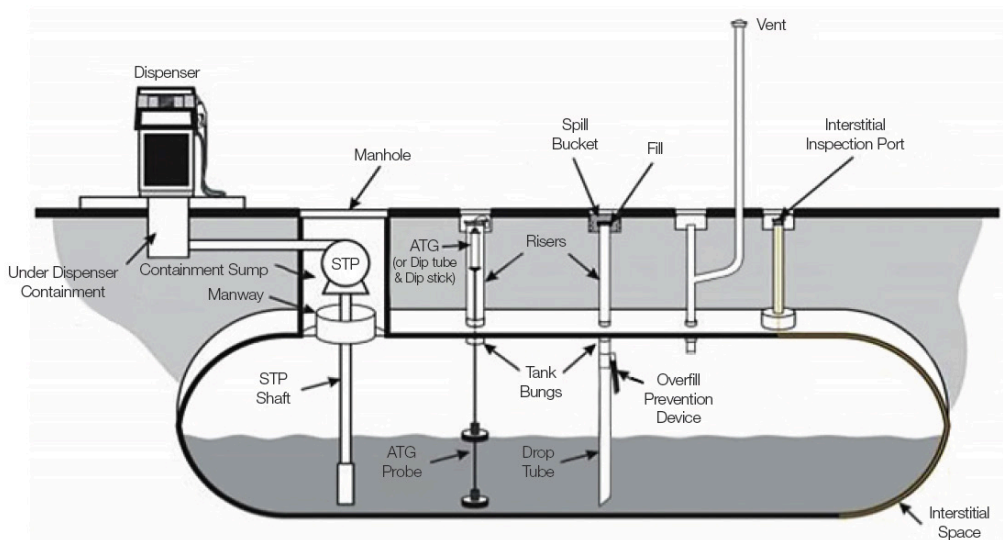


Figure 1: Simplified diagram of a diesel UPSS system

These systems not only include all the underground tanks and piping needed to store and dispense fuel, but also include the use of electronic measurement and management systems that are needed to ensure that fuel system pressures and temperatures are managed in accordance with safe operating practices and consumer standards.

The components of a UPSS typically comprise:

- » Underground tanks
- » Underground pipes and lines
- » Tanker filling point, spill box and associated piping
- » Tank gauging systems (manual or automated)
- » Pressure monitoring systems
- » Dispenser sumps
- » Vents
- » Inspection points

2.2 PURPOSE OF UPSS LOSS MONITORING SYSTEMS

The principal purpose of UPSS loss monitoring is to allow the early detection of losses from UPSS with a view to prompting timely investigation of losses to minimise economic loss and/or environmental harm.

UPSS loss monitoring provides a mechanism for the early detection of system leaks. Fuel system leaks that go undetected over time can cause significant environmental damage and the longer the leaks go undetected, the higher the environmental damage caused and the higher the cost of environmental remediation.

Early detection of these leaks minimises the environmental damage caused by them, which means that the cost of any associated remediation can be minimised.

2. OVERVIEW



2.3 KEY DESIGN CONSIDERATIONS

The design of UPSS loss monitoring systems typically varies according to the nature of the underground tanks and pipe systems that are installed on an individual site. It is for this reasons that a variety of methods and detection systems are available and can be used on a 'mix and match' basis, to suite the specific nature of the installed infrastructure.

Some contemporary UPSS systems (e.g. double-walled tanks and pipes) are sold with interstitial monitoring systems installed, while the extent of leak detection for older sites might merely extend to the capture of data by manual dips and use of daily statistical inventory analysis.

In some Australian states and territories (most notably NSW), specific regulations have been introduced requiring the installation of UPSS monitoring systems to conform with specific performance requirements.

A further consideration in the design of a UPSS system relates to the risk of environmental and community harm that could arise from even a modest fuel leak. Sites that are located close to natural waterways, or those where the groundwater level is close to the surface, are typically required to have more comprehensive UPSS monitoring systems.

In summary, the following factors should be considered in the selection of a UPSS monitoring system for an individual fuel retail site:

- » Nature of the existing UPSS infrastructure, including age of infrastructure and any history of leaks
- » Accommodation of any specific requirements set out in relevant regulations
- » Site topography and proximity to natural watercourse, environmentally sensitive neighbouring properties and other environmental assets
- » Capital cost of installation
- » Ongoing maintenance, testing and calibration costs
- » Training of site staff (where third-party solution providers are not utilised)
- » Nature of the ongoing maintenance burden for site staff

2.4 LEGAL OBLIGATIONS

It is illegal for any business (including fuel retailers) to pollute the environment. Business owners operating in every Australian state and territory are therefore required to take all reasonable precautions to prevent environmental harm.

The nature of these regulations varies markedly between Australian states and territories and fuel retail site operators are therefore urged to check with the appropriate regulatory authority in respect of the specific requirements in their state or territory.

In some Australian states and territories (e.g. NSW), the authorities have gone a step further by introducing specific regulations that stipulate the requirements for the installation and operation of UPSS monitoring systems.

Any contamination incident (i.e. fuel leak) that results in environmental harm is therefore prone to investigation. Such incidents require that the fuel retailer (often including the site owner) demonstrate that all reasonable efforts were made to guard against environmental damage from the operation of UPSS.

Retail fuel site operators therefore need to demonstrate that (a) they have a UPSS monitoring system in place to facilitate the early detection of losses, and (b) that they have a comprehensive process for the investigation of observed losses and rectification of any leaks that may be identified.

2. OVERVIEW



It is worth noting that while the extent of liability generally lies with the Directors of the fuel retail business, there are circumstances where the site owner (i.e. landlord) may also be liable if the leak is shown to pre-date the commencement of the lease for the site operator.

Accordingly, the owners of retail fuel sites are strongly encouraged to ensure that the operators of their sites implement comprehensive UPSS loss monitoring systems and practices.

2.5 COMMERCIAL CONSIDERATIONS

The business case for installation of UPSS monitoring systems is typically developed around the economic consequences that can occur if a major contamination incident transpires.

Where businesses are found to have breached state/territory environmental regulations, they face fines of up to \$1M per incident plus the cost of clean-up and remediation. For most retailers, such costs are business-critical and would likely result in business shutdown.

But there are other commercial reasons for installing good UPSS monitoring systems.

A comprehensive UPSS monitoring system can result in sites having a lower environmental risk from an insurance perspective, leading to lower insurance premiums. (In some cases, the annual insurance savings are higher than the ongoing maintenance cost of these systems.)

The implementation of daily inventory analysis also allows the business to identify incidences of fuel theft or short loading by fuel tankers.

UPSS monitoring systems are specifically designed to detect any losses in the system via the comprehensive and daily monitoring of fuel inventory. The subsequent detection of any such losses signals the need for the site operator to investigate these losses and determine whether the loss is an 'accounting loss' or a 'physical loss' (i.e. leak).

The adoption of a combination of loss detection techniques is generally required to ensure that all elements of a UPSS are monitored to facilitate early detection of losses (and subsequent rectification in the case of physical leaks).

The exact nature of UPSS system monitoring requirements varies markedly across Australian states and territories. It is therefore recommended that retailers consult with the appropriate authorities and/or a qualified petroleum contractor/consultant to ensure that the UPSS monitoring system installed at a site is consistent with all relevant legislative requirements.

In the absence of requirements or guidance by the local authorities, fuel retailers should comply with the minimum methods outlined in Australian Standards AS 4897 - The design, installation and operation of underground petroleum storage systems. (AS 4897 is mandatory for all fuel retail sites in Western Australia.)

In developing a UPSS monitoring system, consideration should be given to the adoption of a combination of internal and/or external monitoring methods.

These methods can be summarised as follows:

- » **Internal monitoring:** These methods utilise detector systems that are installed inside tanks and/or lines to assess the internal state of the UPSS system. These detectors typically measure operational parameters such as system pressures, vapours and liquid volumes. Unexpected variations in these parameters will generally provide an indication that there has been a breach of the system.
- » **External monitoring:** As the name suggests, these methods are external to the UPSS system and may include statistical monitoring of inventory or the installation of wells for observation and/or groundwater monitoring.

3. UPSS MONITORING SYSTEMS



3.1 INTERNAL MONITORING METHODS

These systems involve the monitoring of the internal parameters of the UPSS to allow ready detection of unexpected variations in tank pressures, fuel volumes or water volumes. These systems typically incorporate a combination of the three elements described below:

3.1.1 Tank Gauging

Tank gauging involves the regular measurement of underground tank volumes. This information can then be combined with Statistical Inventory Reconciliation (see below) to create a system that allows for the ready identification of liquid losses - which could be an indication of a fuel leak.

Tank gauging can be performed using a manual method (i.e. regular dips), mechanical devices or electronic devices. While the manual method involves the least capital expense, it is the most labour intensive and is the method that is most prone to errors due to misreading of gauging equipment by staff.

The cost and sophistication of mechanical and electronic systems varies markedly and it is therefore recommended that these systems be installed and serviced by a qualified petroleum contractor. Mechanical and electronic systems need to be calibrated upon installation. This calibration should be conducted periodically in accordance with the manufacturer's recommendations.

3.1.2 Line detectors (mechanical and electronic)

In a typical installation (where submersible pumps are used), a pressure is maintained on the lines connecting tanks and dispensers when the system is not in use. In-line detectors are then used to identify any loss of line pressure, providing an indication of a potential leak.

These systems can be mechanical or electronic and are often supplied by the submersible pump manufacturer, or sold in conjunction with automatic tank gauging (ATG) systems.

Electronic systems can also be configured to actuate an audible alarm (or illuminate a warning light) when a pressure drop is detected. These systems must be installed by a qualified petroleum contractor as incorrect installation can contribute to undetected leaks in the underground piping system.

These detector systems should be regularly inspected and calibrated in accordance with manufacturer specifications. Similarly, any equipment replaced during the life of the system should comply with the original specifications of the manufacturer.

3.1.3 Interstitial monitoring

An 'interstice' is the space between two walls in double-walled piping and tanks or the external space that may exist between single-walled pipes and tanks and any secondary containment system that may be in place.

Liquid interstitial monitoring systems are typically installed in double-walled systems that contain a liquid in the space between the two tank walls. This technique involves the monitoring of movements in this liquid level (either visually or electronically), with observed changes in the liquid level indicating that there may be a leak in either the inner or outer tank.

Dry interstitial monitoring systems are also used in some above-ground, double-walled systems - and all double-walled pipe systems - (or for single-walled tanks that have some form of secondary containment) to monitor concentrations of vapour in soil, pressure variations and/or liquid levels. Interstitial monitoring systems should be inspected at least monthly, or in accordance with the manufacturer's specifications (and records maintained to allow detection of any changes over time).

3. UPSS MONITORING SYSTEMS



3.2 EXTERNAL MONITORING METHODS

External methods include the statistical monitoring of UPSS volumes relative to fuel sales (i.e. 'ins and outs') and the physical monitoring of contaminant concentrations in nearby groundwater (i.e. liquid fuel) or soil (i.e. vapours).

3.2.1 Statistical inventory reconciliation (SIR)

This method involves the statistical reconciliation of fuel loaded into the underground fuel tanks with fuel sales. Where a discrepancy exists, these systems can provide an early indication of either tank leaks, short deliveries, fuel theft or incomplete sales records.

While there are a variety of systems that can be used for this purpose, it is strongly recommended that only systems that are certified to Statistical Inventory Reconciliation (SIR) protocols are used.

The design of these systems should also be wholly compliant with the requirements of AS4897.

SIR protocols require that inventory analysis is performed daily. They also specify measurement regimes and maximum permissible volume variances.

In Australia, this monitoring is typically provided by a third party that analyses daily data and reports any unacceptable variances in tank volumes to the site operator.

As a bare minimum, all service stations should have a SIR analysis system installed and operating in conjunction with a tank gauging system.

Daily reconciliations must be performed - either via an on-site system or via utilisation of a third-party service provider - and comprehensive records of these reconciliations should be kept.

3.2.2 Observation wells

Observation wells are sunk in tank excavations and collection sumps of secondary containment systems. These wells typically extend 300mm below the level of the tanks to detect any product release within the tank pit area.

These wells are generally not utilised unless required by regulations (i.e. retrofit requirement) but are recommended in cases where there have been persistent problems with unacceptable tank leaks (e.g. older tanks).

3.2.3 Groundwater monitoring wells

Groundwater monitoring wells are used to assess the presence of hydrocarbons in groundwater.

These wells should be designed and installed by qualified contractors and the siting of these wells should typically take account of the following:

- » The location of all tanks, pipework, filling points and dispensers that are part of any UPSS on the site
- » The hydraulic gradient on the site. (In order to estimate the direction of groundwater flow, at least three wells are required in an approximately triangular pattern)
- » Topographic slope and boundary conditions on the site
- » The location of any barriers or preferential pathways (e.g. service trenches) which may be present in the substrate of the site

3. UPSS MONITORING SYSTEMS



While these wells are generally not utilised unless required by state/territory or local government regulations, they are recommended for use with old UPSS where:

- a) There have been persistent problems with unacceptable tank leaks (e.g. older tanks)
- b) The site topography and/or proximity to natural watercourses or groundwater warrants the provision of additional precautions

3.3 LEAK INVESTIGATIONS

If a significant loss is detected, the site operator should institute a leak investigation as soon as practical.

For the purposes of this Guideline (and in accordance with SIR protocols), a significant loss is defined as being a loss of 0.76 litres per hour or greater, measured at 95% accuracy.

The process for notification of system losses should be known to all site staff and, ideally, be formally documented in a conspicuous location on the retail fuel site.

Once notified, the site operator should instigate a leak investigation. The scope of this investigation should ideally incorporate the following sequential steps:

- a) A review of inventory records to check for any obvious recording errors
- b) An assessment of the possibility that fuel may have been siphoned directly from the UPSS
- c) An assessment of the accuracy of manual dips, including an examination of the condition of the dip stick to assess the likelihood of reading errors
- d) An investigation to determine whether any water is present in the tanks or pipes by a qualified contractor
- e) Inspection of the physical condition of pumps, pipes and manifolds by a qualified contractor
- f) Review of the observation wells and/or groundwater monitoring wells to determine whether any fuel is present
- g) An inspection of any vents
- h) An inspection of the dispenser pumps and the conduct of pump calibration checks to ensure that the pumps are correctly measuring the volume of fuel that is being dispensed
- i) Testing of the business sales system
- j) Review of any interstitial monitoring systems
- k) Assessment of the potential for human errors in the recording of system volumes
- l) A review of UPSS maintenance records to identify whether any recent repairs have been effected
- m) Review of fuel delivery temperatures
- n) An equipment integrity test (typically only performed if all the above fails to reveal the source of the loss).

4. LOSS MONITORING PRACTICES



4.1 DAILY INVENTORY MONITORING

Fuel site operators should ensure that an analysis of fuel inventory is performed daily.

Such an analysis should be performed in accordance with SIR protocols and should extend to both the daily collection and analysis of information. In addition, this monitoring should:

- » Use equipment that has been installed, calibrated and commissioned in accordance with the manufacturer's instructions for the loss monitoring system
- » Be undertaken by a person suitably trained in each element of the procedure
- » Be conducted in accordance with the service provider's instructions
- » Have a system in place that ensures the appropriate regulatory authority (ARA) is informed if there is a significant loss and appropriate corrective action is undertaken. (A 'significant loss' is a loss defined by regulation. If no regulation exists, then such a loss can be considered as 0.76 litres per hour or higher as measured with at least 95% accuracy).

4.2 PERFORMANCE OF MONITORING TASKS

For the reasons outlined at the outset of this Guideline, the monitoring of UPSS performance is a business-critical task. Any failure to detect (and rectify) leaks from UPSS systems can result in business interruption and consequential loss of revenue.

Careful thought should therefore be given to the conduct of the UPSS monitoring task. This task should be performed by someone (either site personnel or third-party contractor) who is competent and experienced in the performance of such tasks.

Where on-site employees are performing the monitoring, these employees should be appropriately trained in both the interpretation of data and the escalation procedures that should be adopted in the event of a discrepancy being observed. Where third-party service providers are used, it is vital that inventory data be uploaded to the provider for daily analysis.

4.3 SYSTEMS MAINTENANCE

All measurement systems are only effective if they are regularly inspected, tested and calibrated.

Failure to ensure that detectors and other measurement equipment are correctly calibrated can lead to the production of false readings. This, in turn, could result in the failure of installed UPSS monitoring systems to detect a significant leak, thereby creating commercial and legislative risk.

Testing and calibration of UPSS monitoring systems should be performed in accordance with the recommendations of the system manufacturer (or product provider) and should be conducted by competent and experienced personnel.

4.4 RECORD KEEPING

Detailed records should be kept of both inventory monitoring and system maintenance in accordance with the requirements of AS 4897 and relevant state/territory regulations.

These records must be held either on site (or at an appropriate off-site location) and be readily accessible by key staff and maintenance personnel.

The presence of a comprehensive set of UPSS monitoring records is valuable in instances where the fuel retailer may be the subject of an investigation by a regulator (as it provides evidence that the fuel retailer has systems in place to minimise environmental harm from their operations).

SUMMARY



The contamination of soil or groundwater due to a breach of UPSS at a fuel retail site typically carries a high risk of economic loss and environmental harm.

The remediation costs of such events are significant and can often force smaller fuel retail businesses to shut down altogether.

It is therefore critical that fuel retailers (especially small fuel retail businesses) adopt comprehensive UPSS loss monitoring practices that:

- a) Are consistent with all relevant environmental and planning regulations
- b) Take due account of site-specific considerations such as local topography (i.e. located at the top of a hill or in a valley), proximity ground water, proximity natural water courses and/or proximity to environmentally sensitive land-use
- c) Are conducted in accordance with any relevant state/territory regulations.

UPSS should only be installed in accordance with the manufacturer's instructions (and appropriate Australian Standards) and should be maintained by personnel who are trained and qualified in the design, installation and operation of such systems.

As a minimum, UPSS loss monitoring systems should be compliant with the requirements of Australian Standards 4897 which stipulate the use of regular tank gauging and daily statistical analysis of fuel inventory.

Further information about this Guideline can be obtained by contacting ACAPMA on 1300 160 270 or emailing the ACAPMA Secretariat at communications@acapma.com.au.

GLOSSARY OF TERMS



ARA	Appropriate regulatory authority. Refers to the state or territory authority that is responsible for ensuring compliance with relevant regulations.
SIR	Statistical inventory reconciliation. This is a formal process for the progressive measurement of fuel inventory to identify significant system losses. Under SIR, a significant loss is defined as a loss of 0.76 litres per hour or greater (measured at 95% accuracy).
UPSS	Underground petroleum storage systems. Refers to the underground equipment (i.e. tanks, pipes and pumps) that are used to receive, store and transport the fuel to the forecourt pumps.

USEFUL REFERENCES



Standards Australia (2008)	AS 4897 (2008) - The design, installation and operation of underground petroleum storage systems www.infostore.saiglobal.com/preview/as/as4000/4800/4897-2008_r2016.pdf?sku=318742
US EPA (2014)	Statistical Inventory Reconciliation www.epa.gov/sites/production/files/2014-03/documents/sir.pdf
NSW EPA (2008)	Guidelines for implementing the protection of the environment operations (Underground Petroleum Storage Systems) Regulation 2008 www.epa.nsw.gov.au/resources/clm/09653upssglines.pdf
EPA Victoria	The design, installation and management requirements for underground petroleum storage systems (UPSS) www.epa.vic.gov.au/~/_/media/Publications/888%204.pdf

ABOUT THIS DOCUMENT

This document is one in a series of *Best Practice Guidelines* that has 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 of a general nature only. It is not intended for use by suppliers of equipment and services to the fuel retail industry in Australia given that much of this information is already detailed in relevant Australian Industry Standards and related Legislative Guidelines.

Rather, the information contained in this document 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 key aspects of their retail fuel sites.

Fuel retailers seeking detailed information in relation to the design and/or alteration of service station infrastructure are strongly advised to secure the services of a qualified fuel system designer and/or petroleum services contractor.

The contact details of such contractors can be obtained by visiting www.acapma.com.au or calling the ACAPMA Secretariat on 1300 160 270.

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