Leaking Drop Tubes

Petrol Filling Stations - Safety Implications of Leaking Drop Tubes & Vapour Retention Devices

FOREWORD

This guidance supersedes and expands on all guidance given in previous PETELs on the subject, and forms part of a series of PETELs issued as part of the PELG-PETEL series from 2012 onwards by the Petroleum Enforcement Liaison Group (PELG), a health and safety advisory committee hosted by the Energy Institute. It comprises representatives of the Retail Petroleum Industry, the Petroleum Enforcing Authorities (PEAs), UKLPG and the Environment Agency, with technical support from the Health and Safety Executive.

PETELs are a mechanism for PELG to promulgate advice, guidance and good practice with the purpose of:

- Facilitating appropriate and consistent enforcement by PEAs; and/or
- Advising duty-holders on how to comply with the law.

The guidance is directed at those with a responsibility for the safe operation of facilities where petrol is stored and dispensed into vehicle fuel tanks, to enable them to comply with the relevant health & safety legislation; in particular their statutory duties under the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR). The guidance is not meant to be prescriptive and alternative methods of controlling the risks of fire and explosion may be followed where these provide an equivalent level of safety. However, if this guidance is followed, site operators will normally be able to demonstrate their compliance with the law.

Note: This PELG-PETEL was revised in January 2015 to replace the references to the Petroleum (Consolidation) Act 1928 and petroleum licensing authorities with the Petroleum (Consolidation) Regulations 2014 and petroleum enforcement authorities. There are no alterations or amendments to the technical content.

Important disclaimer

This guidance has been produced and reviewed as described in the foreword. The Energy Institute (EI) shall have no liability arising out of or in connection with this guidance or its use or application whether in contract, tort (including but not limited to negligence), breach of statutory duty, under statute, by reason of misrepresentation or otherwise.

INTRODUCTION

1. Since vapour recovery was first introduced at UK petrol stations in 1998, there have been a number of incidents where petrol or petrol vapours have
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escaped (in the most extreme incidents with some force) from the storage tank fill pipe connection when a road tanker delivery is taking place. In some instances these releases are known to have resulted in fires and explosions that have had the potential for escalation into very serious incidents. One of the main reasons for these occurrences is a breach of integrity between the internal drop tube and the ullage space of the storage tank. In the worst cases this is due to the drop tube not extending to below the level of the suction pipe and therefore not maintaining a liquid seal, or because the drop tube is not present at all. Less serious incidents are due to leaks around the drop tube joints and overfill prevention device (OPD) fittings. Leak testing carried out as part of the maintenance regime for vapour recovery systems has identified a large failure rate for internal drop tubes. Additionally some very poorly installed drop tubes have been left electrically insulated by the sealing ring which may have allowed sufficient static electricity to build up on the drop tube to create an incendive spark and ignite the petrol vapours.

2. In response to concerns raised by certain sections of the industry and PEAs (formerly PLAs) as to the safety implications arising from leaking fill pipe systems, PELG set up a small working group, in collaboration with the Energy Institute. The remit of the working group was to establish an acceptable leak rate for fill pipe systems that will not:
   a) give rise to safety implications during vapour recovery deliveries; and
   b) prejudice the integrity of the drop tube by allowing a 'flame path' into the storage tank ullage space.

3. The working group was also asked to look into the safety implications that could arise when vapour retention devices are fitted at sites operating with vapour recovery systems.

BACKGROUND

4. Ideally from a theoretical and practical point of view there should be a total liquid and vapour seal between the internal drop tube and the ullage space of the storage tank. The drop tube should also have good metal-to-metal contact with the tank to provide electrical continuity and to ensure there are no insulated components. However, the limitations in the traditional design and engineering of tanks and associated fittings, together with many instances of poor installation and maintenance, mean that it has been extremely difficult to attain, let alone maintain, a completely vapour tight seal. The main reasons being the:
   - construction of some OPDs, which may not have been the designed to be vapour tight; and
   - stress effects during deliveries on the joint of the drop tube with the tank lid and also the OPD where fitted.
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5. The draft European Standard EN 13616(1) for OPDs allows for both 'vapour tight' and 'non-vapour tight' devices depending on whether or not vapour recovery is installed. In the case of vapour tight OPDs, the draft standard for new equipment stipulates that the devices should retain an over-pressure of 3.5 kPa (35 mbar) for five minutes and there shall be no visible leaks when checked with a leak detection medium when newly installed.

STANDARDS FOR NEW INSTALLATIONS

6. At new sites and sites undergoing tank replacement or major tank refurbishment, all components of the drop tube system that are installed within the potential ullage space of the tank should be designed and installed to meet the leak rate performance requirements of EN 13616(1) for vapour tight OPD when newly installed. These requirements are detailed in section 5.5.4.8 of the standard and repeated in paragraph 5 (above). The components of the drop tube system include the drop tube itself, any additional equipment such as an OPD, or a device to accelerate the evacuation of air/vapour trapped in the tanker hose and the drop tube at the commencement of the delivery and the joints between the man-lid and the overfill protection device. It is not considered feasible for this equipment to remain completely 'vapour-tight' during its lifetime. The requirements of paragraph 7 should apply following use.

STANDARDS FOR EXISTING INSTALLATIONS

7. At existing installations it may not be possible or practicable because of wear and tear and poorly installed or designed fittings to achieve a leak free drop tube system without expensive repair work. However, extensive field trials and troubleshooting on malfunctioning vapour recovery systems has shown that an overall leak rate from the drop pipe system of less than 2 litre/min (at a test pressure of 30 mbar) does not normally cause any practicable problems during deliveries or give rise to any additional safety problems. It has also been established that a leak rate greater than 5 litre/min can give rise to significant problems during deliveries and would normally require urgent remedial work. A leak rate of between 2 and 5 litre/min can be problematic and should be remedied as soon as is reasonable practicable.

8. Where a site operator has established that the drop tube systems are not vapour tight he will need to assess the situation to determine the fault and the most appropriate course of action for his installation. The limit figures in paragraph 7 can be a useful guide but the site operator will need to consider the consequences of excess pressure build-up in fill pipes and what are reasonable practicable measures at that site. The competent person testing the installation should also be a useful source of advice. Additionally, after
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any repair work has been carried out, consideration needs to be given to re-evaluating the whole system to ensure that the repair is effective and that there are no other problems that may have been masked by a larger fault.

ELECTRICAL CONTINUITY

9. In order to prevent a hazardous electrostatic charge building up on the drop tube there should be good electrical continuity between the drop tube, the tank lid and the rest of the internal fill pipe system. Factors giving rise to poor electrical continuity include:
   - corrosion;
   - loose drop tube retaining clamps allowing movement and intermittent metal-to-metal contact; and
   - additional sealing gaskets between the drop tube and the retaining clamp.

10. Drop tubes should be designed and maintained to ensure good metal-to-metal contact between the tank lid and the rest of the internal fill pipe system.

LEAK TESTING

11. Any suitable dynamic or static method can be used to test for leaks on the drop tube system provided the results can be interpreted in terms of leak rate at a pressure of 30 mbar or compared to the performance requirements of EN 13616(1).

12. Test methods to determine the leak rate should be capable of measuring a directional flow rate of petrol vapour (or a test medium gas/vapour) from the tank ullage space into drop tube.

13. In order to determine the integrity of the drop tube connection to the tank lid or the offset fill pipe, the internal drop tube and any fittings should be tested in situ.

14. Drop tube systems and associated equipment, e.g. OPDs, should be leak tested:
   - when the storage tank is commissioned;
   - when any modifications or repairs/replacements have been carried out that affect the internal fill tube or associated fittings; and
   - as part of a fault finding exercise when problems occur with the vapour recovery system.
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OVERFILL PREVENTION DEVICES

15. A poorly installed or maintained OPD, on a site provided with vapour recovery, can give rise to just as significant but different fire and explosion hazards when compared to the risk of an overfill for sites without overfill protection. It is extremely important, therefore, to ensure when OPDs are installed that the drop tube has been properly re-fitted and that any leaks from the OPD or any of the disturbed joints are reduced in accordance with this guidance.

16. If OPDs are to be fitted or replaced, only OPDs meeting the performance requirements of EN 13616\(^{(1)}\) for 'vapour tight units' should be installed. Alternatively, 'non vapour tight' units could be removed without the need for replacement provided the existing drop tube is also replaced with a sealed (vapour tight) fitting. In the latter case a 'high level alarm' will have to be installed if 'unassisted driver deliveries' take place (See paragraphs 87,88 and 89 of ACOP\(^{(2)}\) Unloading petrol from road tankers).

DELIVERY PROCEDURES

17. The unloading of a road tanker at a site where a vapour recovery system is installed involves the combined process of replenishing fuel stocks and recovering the displaced vapour. The momentum for creating the vapour return flow to the road tanker's compartments is the combined effects of the head of petrol in the compartment forcing (pushing) the vapour into the vapour recovery pipework and the negative pressure in the road tanker compartment (pulling) the displaced vapour into that compartment. This combined effect, using only the forces of nature, creates positive and negative pressures in the closed circuit vapour recovery system. There is, therefore, a potential to put the whole vapour recovery system under excess pressure if there is a malfunction or a blockage in any part of the system. The pressure/vacuum (p/v) valve fitted to the outlet pipe on the site's vent stack is a safety valve designed to open at a positive pressure of 35 mbars thereby releasing to atmosphere any over-pressurisation of vapour in the system. However, p/v valves are exposed to the effects of all weather conditions and have been known to stick in the closed position.

18. The effects of over-pressure in the system, should the p/v valve fail to operate correctly, are that:
   - quick release fill pipe caps\(^{(3)}\) can act as projectiles when the release mechanism is opened;
   - petrol can be forced out of the fill pipes if the caps are not securely fastened; and
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- damage could be sustained to the storage tank (in the form of leaks) and internal fittings.

19. Site operators and road tanker operators should, therefore, have a written procedure for their respective employees to follow. The procedures should include, and where appropriate supplement, the requirements/guidelines detailed in paragraphs 120 to 126 of the AcoP\textsuperscript{(2)} Unloading Petrol from Road Tankers.

20. A further point that should be taken into consideration is the effect of following the same sequence of filling the storage tanks. Repeatedly following the same sequence has been known to mask a defect on the vapour recovery equipment and tank fittings\textsuperscript{(4)}. In order to identify any latent faults, it is recommended that the sequence in which tanks are filled should be varied from time to time.

21. If diesel is unloaded at a site with the vapour recovery hose connected, it is possible for flammable concentrations of petrol vapour to be drawn into the diesel storage tank. Site operators will need, therefore, to ascertain and review the delivery procedures in use at their site. Where they involve unloading diesel at the same time as petrol or prior to the petrol, but with the vapour recovery hose already connected, they will need to ensure that the fill pipe systems for the diesel tanks are designed and maintained to the standards detailed in this guidance for petrol tanks.

22. At sites where it is considered that the diesel tank fittings are not to a suitable standard or the vapour losses are adversely affecting the stock reconciliation procedures, it will be necessary to unload the diesel before commencing petrol deliveries and before connecting up the vapour recovery hose. In these circumstances the site operator will need to notify the tanker operator in accordance with paragraph 71 of the ACOP\textsuperscript{(2)} Unloading Petrol from Road Tankers.

TRAINING

23. Training has an important role to play in the safety of road tanker deliveries and in identifying any faults in the vapour recovery system at an early stage. In order for road tanker drivers and any site personnel involved with the unloading process to identify and where relevant deal with the consequences of faults on the vapour recovery system, their training should cover the following points:

- Basic principles of vapour balancing/recovery related to the type of system being installed
- The signs and symptoms of vapour leaks.
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- Monitoring the delivery for vapour leaks and the reporting/recording procedure of instances of vapour lock\(^{(b)}\), vapour leak, equipment failures, or unusually slow deliveries.
- The precautions to be taken should there be a malfunction of the equipment, which over-pressurises the system.

24. At sites where 'unassisted driver deliveries' take place, an agreement should be in place whereby there is a procedure for the tanker driver to notify the site operator of any problems that occur during deliveries.

VAPOUR RETENTION DEVICES

25. As the basic principle on which the standard vapour recovery system works is the balancing effect whereby the vapours displaced from the storage tanks are returned to the road tanker, it stands to reason that any device designed to retain vapours in the storage tank will interfere to some extent with this natural momentum. It is, therefore, imperative that the fitting of any type of vapour retention device will not adversely affect the safety of the unloading process. It is also important that they do not cause a pressure or vacuum build-up within the storage tanks in excess of the P/V valve settings of +35mbar or -5mbar. In these respects, the advice of a competent person should be sought before a vapour retention device is fitted.

TANKS THAT ARE EMPTY OR LOW IN PRODUCT AT OPERATING SITES

26. The Red Guide\(^{6}\) gives operational guidance on what to do in these situations.

COMMISSIONING NEW/REDEVELOPED SITES

27. The APEA/EI Blue Book\(^{7}\) Chapter 5 gives guidance on acceptance, verification and commissioning sites. Paragraph 5.3.3 is particularly relevant.

REFERENCES

(1) BS EN 13616: 2004 ‘Overfill Prevention Devices for Static Tanks for Liquid Petroleum Products’

(2) HSE L133 ACoP Unloading Petrol from Road Tankers. (2\(^{nd}\) edition 2014) ISBN 978 0 7176 6634 8

(3) IP research paper on thermite reaction recommends tethering quick release caps as a control measure.

(4) An incident occurred at a filling station in Leeds in 2002 when a quantity of petrol escaped, with some force, from the delivery hose when the tanker driver disconnected the hose from the tanker faucet. At the time, the driver
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had completed unloading the first compartment. A subsequent investigation into the incident found that the internal fill pipes of the tank in question and one other tank had dropped-off at some time in the past. The fault had gone unnoticed due to the site being fitted with off-set fills and the failure to carry out any kind of testing when the vapour recovery system was installed. The investigation concluded that an out of ordinary sequence in which the tanks were filled on this particular delivery caused a pressurisation of the system due to the absence of the internal fill pipe. All the previous deliveries, that followed an identical sequence of tank filling, had masked the faults on the system.

(5) Vapour lock is a phenomenon that can occur during a road tanker delivery and is identified by a stoppage in the flow of product before the road tanker’s compartment is fully discharged. There are two possible causes of vapour lock:

i. Where there is an insufficient head of product in the road tanker compartment to force the air/vapour through the residual product in the storage tank. This cause of vapour lock can affect both atmospheric (free venting) and vapour balanced deliveries.

ii. Where there is a back flow of vapour into the delivery hose from a leak in the storage tank’s internal fill pipe. This cause will only arise during vapour-balanced deliveries.

(6) Petrol filling stations – guidance on managing the risks of fire and explosion”
www.energyinst.org/ pelg.