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BSI Standards Publication

Petroleum products — Guidelines for good housekeeping

Part 1: Automotive diesel fuels

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National foreword

This Published Document is the UK implementation of CEN/TR 15367-1:2014. It supersedes PD CEN/TR 15367-1:2007 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PTI/2, Liquid Fuels.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Foreword

This document (CEN/TR 15367-1:2014) has been prepared by Technical Committee CEN/TC 19 “Gaseous and liquid fuels, lubricants and related products of petroleum, synthetic and biological origin”, the secretariat of which is held by NEN.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes CEN/TR 15367-1:2007. The update primarily addresses quality issues that can be associated with blends of diesel fuels and Fatty Acid Methyl Esters (FAME) and by low-level contaminants in diesel fuel that can be picked up in supply and distribution systems. These low level contaminants, such as sodium and other inorganic contaminants, have recently been implicated in the formation of internal diesel injector deposits (IDID).

CEN/TR 15367 consists of the following parts, under the general title *Petroleum products - Guidelines for good housekeeping*:

— *Part 1: Automotive diesel fuels*

— *Part 2: Automotive petrol fuels*

— *Part 3: Prevention of cross-contamination*

This part of this Technical Report describes the distribution of automotive fuels in general and diesel in specific detail. Part 2 was subsequently published to provide guidance on petrol distribution and specifically to address ethanol issues. Finally, Part 3 was published to provide additional guidance on preventing cross-contamination of fuel products in common supply and distribution systems. For further information on the relationship between and the history behind each of the parts, see the Introduction to this document.

Introduction

During its meeting held in Cannes on June 27 2003, WG 24 “Specification for Automotive diesel” decided that a guidance document on good housekeeping could be instrumental in preventing potential motoring problems caused by contamination in the supply chain. This was endorsed by CEN/TC 19 resolution 24.5 and resulted in an effective publication of the first Technical Report in March 2006.

When a similar guideline for petrol was being drafted, it was decided to link these two. The best option was to publish them as separate parts of the same CEN document, which is achieved by revising the original CEN/TR 15367:2006 *Petroleum products — Automotive Diesel Fuels — Guide for good housekeeping* as part 1. Apart from some harmonization of wording no changes have been incorporated.

Two additional reports have now been published in this series regarding Automotive Petrol Fuels (Part 2) and the Prevention of Cross Contamination (Part 3).The work on these three documents has been carried out with support from CONCAWE and other stakeholders.

Automotive fuel specifications generally apply at the point of delivery to the customer. To ensure the quality at this point, the best practice is to make sure that the product meets specification when it is dispatched from the refinery and to have systems in place to ensure that it cannot go off-specification on its way to the customer. There will be more than one method or procedure to handle many of the potential contamination issues throughout the distribution chain, thus the advice in this document outlines principles to apply, but does not specify the precise detail of the methods to be adopted in all cases. Nevertheless, it is strongly recommended that all the procedures or measures to be applied along the distribution chain should be defined using a Total Quality Assurance methodology.

1 Scope

This Technical Report provides general guidance on diesel fuel housekeeping. It does not pre-empt national or local regulations but addresses the issues of contamination by water, sediment, inorganic contaminants, or microbial growth that may occur in the supply chain during manufacture, blending, storage and transportation. It does not address contamination by other fuel products nor does it address possible contamination by water or sediment that may occur on-board vehicles. An informative note on vehicle factors is presented in Annex A, however.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 590, *Automotive fuels - Diesel - Requirements and test methods*

3 Supply chain definition

For the purposes of this document, the supply chain is considered to consist of the following four parts:

— refineries,

— terminals,

— filling stations (including retail and industrial customer sites), and

— transportation from refineries to terminals and from terminals to filling stations.

Information on additives beyond the supply chain is given in Annex B.

4 Potential sources of water and sediment in the supply chain

4.1 Water

Water may be picked up by the diesel fuel product at various stages of the supply chain and can be present either as free water or as an emulsion with small droplets of water suspended in fuel. The presence of FAME can increase fuel/water emulsions. The presence of free water can be a contributory cause of corrosion and biological contamination. Entry points for water include:

a) **dissolved or emulsified water** can occur during diesel fuel or FAME manufacturing. Dissolved or emulsified water can remain suspended in fuel or may separate and become free water further along the supply chain depending on the composition of the fuel and storage conditions. Cooling of the fuel blend can cause the dissolved water to coalesce and separate from the fuel;

b) **free water** can occur due to ingress or leaks as a result of, for example, heavy rainfall or through cracks in equipment;

c) **water vapour** (humid air) can enter storage tanks through air vents followed by cooling or condensation on tank walls or vehicle tanks;

Because it is virtually impossible to stop water from entering the supply chain, proper water management is essential. Tank inspections should routinely look for free water at the bottom of storage tanks. Free water, along with emulsified fuel, should be drained to ensure that the remaining fuel is clear and bright and free of extraneous material.

4.2 Potential sources of sediment

Sediment may be due to inorganic or organic contaminants in the fuel. Inorganic contaminants can consist of rust, dirt, dust, corrosion products, and trace materials retained from fuel and FAME production. Organic contaminants can consist of oxidation products, biological growth, and trace materials from fuel and FAME production. Sediments may form over a long period of time under storage conditions.

4.3 Potential sources of biological contamination

Biological contamination can result from the action of microorganisms, such as bacteria, fungi, and yeasts, which are ubiquitous in the environment. Microbes can bloom whenever there is a source of water, air (oxygen), and fuel (as food). The presence of FAME in fuel can encourage growth. As a result, biological contamination is more common in diesel fuels containing FAME than in gasoline containing bio-products.

Biological contamination can lead to bio-derived films and sediments in storage tanks, pipelines, and filters, potentially causing serious operational problems including filter-blocking and fuel dispenser malfunctions. While good housekeeping, including the elimination of water bottoms in tanks, reduces biological growth, severely contaminated tanks may require more severe treatment, including biocide additives.

4.4 Adulterants and contaminants

Diesel fuel shall be free from any adulterant or contaminant that may render the fuel unacceptable for use in diesel engine vehicles.

Sodium at trace levels in diesel fuel has been found to cause deposit problems in some types of diesel fuel injectors resulting in engine failures. Trace sodium can originate from many sources, cannot be easily controlled or corrected in a multi-product distribution system, and cannot be routinely measured at historical concentrations except in a very well-equipped analytical laboratory. Due diligence is therefore advised for ensuring the integrity of vehicle fuel systems by controlling potential sources of sodium and other deposit-forming materials in fuel. Potential sources for sodium in diesel fuel are pipeline corrosion inhibitors, refinery process additives, import terminal or refinery salt driers, refinery processing units, biodiesel blending, contamination from sea water due to logistics systems or airborne sodium in coastal locations (sea salt). See for more detail CEN/TR 16680 [1]. There are currently no known or intended limits for sodium concentrations in diesel fuel.

Other metal ions of concern are zinc, copper and lead. Zinc has a tendency to accumulate in spray-holes and contributes to nozzle coking. Lead is attacked by fuel acids and forms voluminous soap precipitates. Copper is known to catalytically accelerate fuel oxidation.

For more information on preventing contamination by water or sediment that may occur in the supply chain or for avoiding cross contamination, it is advisable to evaluate the ‘good housekeeping’ practices recommended in CEN/TR 15367-3 and to check the report on the investigation regarding internal diesel injector sticking deposits mechanisms [1].

5 Housekeeping guidelines

5.1 Elements of good housekeeping

5.1.1 Operations

Proper attention to detail during all operating activities from product manufacturing to final delivery is essential to guarantee product quality. Operating procedures should be in place covering receipt, delivery, sampling, inspection, testing, and tank draining. These procedures should be reviewed and updated as required, when product quality changes are taking place as a result of new regulations or the introduction of new fuel types.

It is essential that personnel involved at each step in fuel transfers, both company employees and contractors, are properly trained so that they are aware of and understand the importance of applying and continuously improving operating procedures.

If the use of chemicals is considered anywhere in the supply chain for housekeeping purposes (e.g. corrosion protection or biological remediation) the potential impact on fuel quality and performance should be investigated thoroughly. Non-chemical solutions are generally preferred.

5.1.2 Hardware

The age and design of existing hardware along the supply chain vary widely and yet it is possible to control product quality properly with differently engineered installations. Quality control, however, is much easier if hardware is first designed with the intention to facilitate good housekeeping as described in the following sections.

5.1.3 Maintenance

No matter how well designed an installation may be, equipment faults can develop over time if the equipment is not inspected and properly maintained. Inadequate maintenance can eventually affect the ability of the operator to maintain product quality at the required level.

5.2 Detailed recommendations

5.2.1 General

Recommendations in this section are divided into four sections covering various elements related to refineries, terminals, filling stations and transportation. This guidance represents current industry best practices but is largely based on experience handling hydrocarbon-only diesel fuels.

5.2.2 Refineries

5.2.2.1 Testing

Batches of diesel fuel should first be visually assessed for clear and bright appearance with no free water and free from visible sediment. When testing for visual appearance, the prevailing ambient temperature should be considered. Alternative methods such as online haze meters may be used. The product shall meet the water content and total contamination requirements of EN 590.

When a sample is not visually acceptable, it should be analysed to quantify the problem. Analysis at this point enables any issues to be resolved at the refinery and avoid the problem becoming more widespread. Product imports at terminals should be tested using the same procedures recommended for terminals (see 5.2.3). Batches that are delivered by barge or by sea-going vessels should receive special attention to ensure that they conform to quality specifications. Test records and retained samples should be kept for a sufficient period to cover market needs.

5.2.2.2 Sampling

Upper, middle and bottom samples should be taken from fixed off-take storage tanks for visual assessment and analysis. All three samples should be examined for visual appearance, including confirmation that the blend is not layered. Composite samples may be used for the other routine specification tests.

No special requirements are specified with respect to settling time, after blending and before sampling. If product samples do not satisfy the visual appearance, water content or sediment tests, allowing time for settling is one measure that can be employed to bring the product on specification. It should be noted, however, that settling time alone is unlikely to alleviate high water contents in diesel fuels containing FAME. Water can remain dispersed in the fuel increasing the potential for water accumulation or biological contamination problems elsewhere in the supply chain.

5.2.2.3 Operations

Although some storage tanks have floating off-take points, most have fixed off-take points so that procedures to avoid build-up of water bottoms are essential. Most storage tanks are flat bottomed, although they can be in a cone-up or cone-down configuration. Procedures to control water build-up (e.g. by regularly checking for water bottoms and draining off water as required) should be established based on local experience with the particular tank configuration, fuel production process and local climate. Water bottom checks should be carried out frequently and tanks should ideally be checked both before and after the receipt of new product. These procedures should ensure that water is not carried forward to the next stage of the supply chain.

Diesel tanks should also be checked periodically for biological contamination and there should be a procedure in place to deal with such contamination if it is detected. Once established, biological growth can be difficult to rectify – prevention is better than a cure and is best achieved by good water management.

5.2.2.4 Hardware requirements

New tanks should be designed to optimize water draw-off capability and be fitted with antiswirl systems to minimize mixing of tank bottoms during filling.

They should also have convenient facilities for taking three samples:

— upper sample at one-sixth of the depth of liquid below the maximum level;

— middle sample halfway down the depth of the liquid;

— lower sample at approximately one-sixth up from the bottom level representing the product which will be drawn out of the off take system. The precise height for the lower sample should be based on details of tank configuration including the height of the off-take point.

Filtration of the final product is not generally necessary to control water and sediment. Filters may be installed as an additional safeguard in some situations.

5.2.2.5 Maintenance

Tank cleaning is a major disruptive operation which requires completely draining the tank and physical scraping to remove biofilms and other sediments. Tanks should be inspected on a regular basis and cleaning should be carried out if there is evidence of a significant build-up of biological contamination. Routine cleaning is normally carried out on a several years schedule, coinciding if possible with (statutory) inspection and maintenance requirements. Good housekeeping can help to extend the periods between tank cleaning.

5.2.3 Terminals

5.2.3.1 General

A documented procedure should be in place for product sampling and quality monitoring upon product receipt. Checks should confirm that the product has not become contaminated with water or dirt. These principles should also apply to product imports into refineries.

5.2.3.2 Testing

Visual checks should be carried out to assess the quality of the product and additional analysis may be carried out if needed.

Batches delivered by barge or by sea-going vessels need more careful attention to conform to quality specifications.

Test records and retained samples should be kept for a sufficient period to cover market needs.

5.2.3.3 Sampling

In order to avoid possible contamination of clean product tanks, sampling should be considered from:

— from the transport unit (e.g. barge) delivering the product before discharging into storage tanks;

— during product transfer to the receiving tank. In some cases, e.g. for pipeline deliveries, online or running samples may be monitored; and

— in the storage tank after receipt.

Because the receiving tank will be used for deliveries, it should be sampled in any case based on upper/middle/lower samples as with the refineries. The quality of the existing product in the receiving tank before transfers should also be known.

As recommended at refineries, no special requirements are specified with respect to settling time before sampling. If product samples do not satisfy the visual appearance, water content or sediment tests, allowing time for settling is one measure that can be employed to bring the product to specification. It should be noted, however, that settling time alone is unlikely to alleviate high water contents in diesel fuels containing FAME. Water can remain dispersed in the fuel increasing the potential for water accumulation or biological contamination problems elsewhere in the supply chain.

5.2.3.4 Operations

Normal practice should include that the product is not dispatched from a running tank, i.e. from a tank that is receiving product at the same time. Where terminal operations require product delivery from a running tank, additional precautions should be taken to ensure that quality is maintained, e.g. pre-delivery checks on the receipt tank and incoming product.

Similar procedures to those used at refineries should be in place to monitor and control water accumulation and potential biological contamination in tanks.

5.2.3.5 Hardware

As in refineries, new tanks should be designed to optimize water draw off-capability and be fitted with antiswirl systems to minimize mixing of tank bottoms during filling. Floating off-takes, which pick-up product from the upper layer, can also help avoid further transmission of water and sediment problems.

Filtration is not generally necessary but filters may be installed as an additional safeguard in certain circumstances. If fine filters are used, care should be taken to avoid build-up of static electricity in the product.

5.2.3.6 Maintenance

As recommended at refineries, tank cleaning is a major operation and the frequency of cleaning can be minimised by good housekeeping and water management.

5.2.4 Filling stations

5.2.4.1 Sampling and testing

Filling stations are not an easy place to perform product quality testing. The best practice is therefore to ensure product quality at the filling station by actions taken before product is delivered to the filling station in order to avoid contaminated fuel reaching this point. Robust procedures will also help to ensure that a clean product is delivered into the correct tank at the filling station. Nevertheless, a best practice is to periodically conduct product sampling and testing to ensure that the fuel being sold to consumers is fit for purpose and complies with the prevailing specifications.

Sampling and testing are critical steps in assessing fuel quality, in particular with regard to free-water and/or sediment contamination issues. Information on sampling can be found in the sampling standard procedures [3], [4] and [5].

5.2.4.2 Operations

Water bottom measurements should be made on an appropriate time interval (e.g. via automatic gauging or regular tank dipping with water finding paste) and water should be removed when necessary. This is particularly important since any water and sediment can be stirred up when the tank is filled with new product. Procedures should allow for local conditions, e.g. rainfall, tank breathing through temperature fluctuations etc.

Attention should also be paid to inspection pits to avoid water ingress.

5.2.4.3 Hardware and maintenance

A best practice is for automatic fuel level recording and water bottom measurements, and devices for these purposes should be fitted to all new facilities.

All transfer hoses and connectors should be maintained in a clean and dry condition before use.

Tank conditions should be checked periodically to avoid build-up of dirt, rust and sediment consistent with Underground Storage Tank (UST) rules [6].

NOTE EU Member States requirements for Underground Storage Tanks differ. In most countries, specifications exist for tank construction, corrosion protection and leak detection. These regulations have been set mainly from a safety and environmental protection point of view, but also serve to avoid product contamination.

Fuel storage tanks and associated equipment should be periodically inspected. If needed, a tank cleaning programme should be implemented to prevent build-up of biological contamination that could contaminate the fuel and delivery system and potentially cause problems for consumers.

5.2.5 Transport and operations

Procedures should be in place to minimize contamination risks during transport. These may include:

— refinery procedures for visual inspection of sea going vessels or barges prior to loading; or

— procedures to ensure good clean condition of delivery vehicles.

5.3 Handling of biofuels

European market experience blending diesel fuel and FAME complying with EN 14214 is growing as a result of the EU (Biofuels) Directive 2003/30/EC [7] and the following Amendment [8] introducing B7 blends. Most of the operating practices described in this report for hydrocarbon fuels will also apply to handling blends of FAME and diesel fuel and FAME as well. Good water management is even more important with biofuel blends because they are by nature hygroscopic.

Annex A
(normative)

Diesel vehicle factors

A.1 General remarks

Modern diesel vehicles are sensitive to water and sediment in diesel fuel due to the very fine tolerances in their high-pressure fuel injection systems. The previous section described measures that can be taken in the fuel supply system to ensure the cleanliness of fuels delivered to the vehicles. However, even after clean and dry fuel has been delivered, vehicle factors shall also be considered to achieve trouble-free operation.

A.2 Fuel tank

Breathing of the fuel tank during diurnal temperature cycles means that moist air can be drawn into the tank allowing water to condense in the fuel. Water and particle ingress is also possible if fuelling occurs under wet or dusty conditions. Metal tanks can be a source of particulate contamination, especially when metal surface coatings or corrosion is present.

Cleanliness of fuel containers and the age and condition of the fuel used for emergency re-fuelling shall also be taken into account to avoid particulate and water contamination.

Vehicle fuel tanks should be designed so that any accumulated free-water or particulate matter can be routinely drained from the tank during regular vehicle servicing. The fuel suction line should also not be located too close to the lowest point of the vehicle tank.

A.3 Fuel system temperature cycles

Some modern fuel injection systems generate very high temperatures in the high-pressure system, and even in the fuel return to the fuel tank. Under these conditions any free water that has accumulated in the tank will probably be dissolved, and may separate from the fuel when the vehicle is stopped and cooled overnight.

A.4 Filters

Fuel filters are capable of protecting sensitive fuel components. If more protection is needed, finer filters can be used, but more filtering surface area would probably be needed to avoid premature plugging. In all cases, it is important to follow the vehicle manufacturers' recommendation on filter changes.

Plugging of filters by wax under some cold conditions should not be a barrier to using better filters: Wax crystals are generally much larger than the filter pore size and cold operability is usually influenced by vehicle design features that ensure a fast warm-up of the fuel supplied to the engine so that it arrives at the fuel filter at a temperature that is already higher than the fuel's cloud point.

Fuel filters are also capable of removing small amounts of free water from the fuel, thus protecting the fuel injection equipment. However, adequate provisions shall be made for accumulation and eventual draining of the water from the filter housing.

Annex B
(normative)

After-market additives

The oil industry goes to considerable effort to ensure that their fuels, including additives where used, are fit for purpose. Therefore, the use of aftermarket additives is not recommended, in particular, additives which create emulsions as a means to pass water through vehicle fuel systems.

Bibliography

[1] CEN/TR 16680, *Liquid petroleum products - Investigation on internal diesel injector sticking deposits mechanisms and the impacts of corrosion inhibitors*

[2] EN 14214, *Liquid petroleum products - Fatty acid methyl esters (FAME) for use in diesel engines and heating applications - Requirements and test methods*

[3] EN 14275, *Automotive fuels - Assessment of petrol and diesel fuel quality - Sampling from retail site pumps and commercial site fuel dispensers*

[4] EN ISO 3170, *Petroleum liquids - Manual sampling (ISO 3170)*

[5] EN ISO 3171, *Petroleum liquids - Automatic pipeline sampling (ISO 3171)*

[6] UST Rules

[7] Directive 2003/30/EC of the European Parliament and of the Council of 8 May 2003 on the promotion of biofuels or other renewable fuels for transport

[8] Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC

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