SLOVENSKI STANDARD
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Sistemi za kontrolo tesnosti - 5. del: Zahteve in metode za preskušanje in ocenjevanje sistemov zaznavanja netesnosti, vgrajenih v rezervoarje in tlačne cevovode

Leak detection systems - Part 5: Requirements and test/assessment methods for in-tank gauge systems and pressurised pipework systems

Leckanzeigesysteme - Teil 5: Anforderungen und Prüf-/Bewertungsmethoden für Tankinhaltsmesssysteme und druckbeaufschlagte Rohrleitungen

Systèmes de détection de fuites - Partie 5 : Exigences et méthodes d'essai/d'évaluation des systèmes de détection de fuites en citernes et des systèmes de tuyauterie sous pression

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ICS:

23.020.10	Nepremične posode in rezervoarji	Stationary containers and tanks
23.040.99	Drugi sestavni deli za cevovode	Other pipeline components

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English Version

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COMITÉ EUROPÉEN DE NORMALISATION
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European foreword

This document (EN 13160-5:2016) has been prepared by Technical Committee CEN/TC 393 "Equipment for storage tanks and for filling stations", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2017, and conflicting national standards shall be withdrawn at the latest by April 2018.

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 EN 13160-5:2004.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

According to EN 13160-5:2004 the following fundamental changes are given:

— Requirement for a device for simulating a leak deleted;

— requirements from EN 13160-1:2003 included, which are no longer contained in EN 13160-1:2016;

— Pressure line leak detection kits included.

This European Standard, *Leak detection systems,* consists of 7 parts:

— *Part 1: General principles*

— *Part 2: Requirements and test/assessment methods for pressure and vacuum systems*

— *Part 3: Requirements and test/assessment methods for liquid systems for tanks*

— *Part 4: Requirements and test/assessment methods for sensor based leak detection systems*

— *Part 5: Requirements and test/assessment methods for in-tank gauge systems and pressurized pipework systems*

— *Part 6: Sensors in monitoring wells*

— *Part 7: Requirements and test/assessment methods for leak detection linings*

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This European Standard gives requirements and corresponding test\assessment methods applicable to leak detection kits, based on volumetric loss from within the tank and/or pipework system. The kits usually comprise:

— Measuring Device

— Evaluation Device

— Alarm Device

Intended use:

Leak Detection kits are intended to be used in\with single or double skin underground tanks or single or double skin underground and/or aboveground pipework designed for flammable liquids having a flash point not exceeding 100 °C.

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 228, *Automotive fuels — Unleaded petrol — Requirements and test methods*

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

EN 976-1, *Underground tanks of glass-reinforced plastics (GRP) — Horizontal cylindrical tanks for the non-pressure storage of liquid petroleum based fuels — Part 1: Requirements and test methods for single wall tanks*

EN 981:1996+A1:2008, *Safety of machinery — System of auditory and visual danger and information signals*

EN 12285-1, *Workshop fabricated steel tanks — Part 1: Horizontal cylindrical single skin and double skin tanks for the underground storage of flammable and non-flammable water polluting liquids*

EN 13160-1:2016, *Leak detection systems — Part 1: General principles*

EN 13160-2, *Leak detection systems — Part 2: Requirements and test/assessment methods for pressure and vacuum systems*

EN 13352:2012, *Specification for the performance of automatic tank contents gauges*

EN 14879-4:2007, *Organic coating systems and linings for protection of industrial apparatus and plants against corrosion caused by aggressive media — Part 4: Linings on metallic components*

EN 60296, *Fluids for electrotechnical applications — Unused mineral insulating oils for transformers and switchgear (IEC 60296)*

EN 60529, *Degrees of protection provided by enclosures (IP Code) (IEC 60529)*

EN 61672-1, *Electroacoustics — Sound level meters — Part 1: Specifications (IEC 61672-1)*

ISO 8601, *Data elements and interchange formats — Information interchange — Representation of dates and times*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 13160-1:2016 and the following apply.

3.1.1
quantitative output
numerical indication of the leak rate

3.1.2
qualitative output
pass/fail indication for a given test with reference to a specified leak rate

3.2 Symbols and abbreviated terms

B	is the bias
LL	is the lower confidence bound for probability of detection
UL	is the upper confidence bound for probability of detection
MSE	is the mean squared error
PD	is the probability of detection
PFA	is the probability of false alarm
PI (all)	is the proportion of invalid records for all records
PI (leak)	is the proportion of invalid records for leaking tanks
PI (tight)	is the proportion of invalid records for tight tanks
R	is the simulated leak rate
C	is the criterion or threshold for indicating a leak
B	is the estimated bias of the system
SD	is the standard deviation
t_b	is the two-sample *t*-test bias

4 Requirements

4.1 Effectiveness of leak detection kits

4.1.1 General

This type of leak detection kit is classified according to EN 13160-1:2016 as class IV.

The general requirements on leak detection systems according to Clause 5 of EN 13160-1:2016 shall be met.

The measuring device shall fulfil the requirements according to 5.1of EN 13352:2012.

The level to volume conversion methodology shall fulfil the requirements according to Annex B of EN 13352:2012.

A complete documentation shall be provided by the manufacturer. The documentation shall contain the technical values according to 4.1.2 to 4.1.8 and 4.2.

4.1.2 Electrical or signal cable of the measuring device

In the event of disconnection of the electrical or signal cable or malfunction of the measuring device an alarm condition shall result.

4.1.3 Leak detection kit

The leak detection kit shall consist of:

— measuring device;

— evaluation device;

— alarm device.

4.1.4 Measures volumetric loss

4.1.4.1 General

Table 1 — Performance requirements for categories of leak detection

Category	Type	Alarm threshold leak rate $l \cdot h^{-1}$	Maximum time of detection h
A Dynamic leak detection using the comparison of sales data with tank volume changes	Type 2	≥ 0,8	336
	Type 1	≥ 0,4	336
B(1) Static leak detection	Type 2	≥ 0,8	4
	Type 1	≥ 0,4	8
B(2) Statistical quiet period detection	Type 2	≥ 0,8	24
C Pressure line leak detection (catastrophic loss)	Type 3	≥ 12	1
C Pressure line leak detection	Type 2	≥ 0,8	12
C Pressure line leak detection	Type 1	≥ 0,4	12

Any gauge system to be used for category A, B(1) and B(2) of leak detection shall have water detection capability.

The operating condition of the evaluation device shall be clearly indicated, i.e. through the provision of a fault, light or similar indicator.

For categories A and B, the requirements of a gauge control device as defined in EN 13352 shall be met. An alarm shall be activated whenever a leak rate for Type 1 is detected at the specified rate or above, in accordance with Table 1.

Where performance in accordance with Table 1 for category A and category B is not achievable within the required levels of probability, the results shall be reported as inconclusive.

The leak detection kit shall have a device for automatically shut-off the submersible pump in the event of an alarm condition.

4.1.4.2 Category A – Dynamic leak detection

4.1.4.2.1 Type 2

For this type, the system shall communicate with the metering system, associated with the withdrawal of product from the storage tank, in order to receive details of all volumes dispensed from the tank. At the specified leak rate according to Table 1, the system shall have a probability of detection of at least 95 % while a false alarm rate shall not exceed 5 %.

4.1.4.2.2 Type 1

For this type, the system shall communicate with the metering system, associated with the withdrawal of product from the storage tank, in order to receive details of all volumes dispensed from the tank. At the specified leak rate according to Table 1, the system shall have a probability of detection of at least 95 % while a false alarm rate shall not exceed 5 %.

4.1.4.3 Category B (1) – Static leak detection

4.1.4.3.1 Type 2

For this type, the system shall be capable of detecting the specified leak rate according to Table 1 with a probability of at least 95 % while operating at a false alarm rate of 5 % or less.

4.1.4.3.2 Type 1

For this type, the system shall be capable of detecting the specified leak rate according to Table 1 with a probability of at least 95 % while operating at a false alarm rate of 5 % or less.

4.1.4.4 Category B (2) – Statistical quiet period detection – Type 2

For this type, the system shall communicate with the metering system, associated with the withdrawal of product from the storage tank, in order to receive details of all volumes dispensed from the tank. At the specified leak rate according to Table 1, the system shall have a probability of detection of at least 95 % while a false alarm rate shall not exceed 5 %.

4.1.4.5 Category C – Pressure line leak detection – Type 1

For this type, the system shall be capable, when no product is being dispensed of detecting the specified leak rate according to Table 1 with a probability of 99 %.

4.1.4.6 Category C – Pressure line leak detection - Type 2

For this type, the system shall be capable, when no product is being dispensed of detecting the specified leak rate according to Table 1 with a probability of 99 %.

4.1.4.7 Category C – Pressure line leak detection - Type 3

For this type, the system shall be capable, when no product is being dispensed of detecting the specified leak rate according to Table 1 with a probability of99 %.

4.1.5 Requirements for software

The software, where provided, shall have a facility for self-checking by fulfilling the following requirements:

— a self-diagnostic mode to test the integrity of the system at start up and periodically during use. A negative result of self-diagnostic mode shall result in an alarm condition;

— a facility to check the consistency of the input and output data, malfunction shall result in an alarm condition.

The software shall also provide an algorithmic determination of volumetric loss.

4.1.6 Mechanical construction

Ingress protection for the measuring device shall be at least IP 68 according to EN 60529.

4.1.7 Effects of thermal contraction

The evaluation device for category C shall feature a provision to filter the effects of expansion\contraction resulting from thermal volume change of the fluid and associated vessels and pipework systems.

4.1.8 Alarm device

The alarm device shall generate an audible and visible alarm. The audible alarm shall have a sound level of ≥ 70 dB (A) in a distance of minimum 1 m with a signal according to Table 1 of EN 981:1996+A1:2008 which shall be maintained for a minimum period of 36 h. The audible alarm may be able to be switched off, but the status off should be visible.

The visible alarm shall be clearly indicated. The visible alarm shall have no switch off option.

The alarm device should be designed for connecting an additional alarm device, e.g. signal horn. The output parameter shall be stated.

A test possibility shall be provided to test the functionality of the audible and visible alarm.

4.2 Durability of effectiveness

4.2.1 Durability of effectiveness against temperature

The components of a leak detection system shall meet the requirement as given in EN 13352.

4.2.2 Durability of effectiveness against chemical attack

Parts of leak detection kits which can come into contact with the stored liquid/water or its vapour shall be resistant.

4.2.3 Durability of effectiveness against hydraulic shock (only for measuring devices used on pressurized line)

The measuring devices shall withstand a transient pressure not less than 1,4 MPa.

4.2.4 Durability of effectiveness against fatigue and mechanical wear\degradation, (only for measuring devices used on pressurized line)

At a temperature of (20 ± 5) °C the measuring device shall continue to operate according to Table 1, Category C after 50 000 cycles at a pressure range from 0 kPa to 350 kPa.

4.2.5 Durability of effectiveness against microbiological growth on critical surfaces involved in the measurement process

Microbiological growth is generated based on the presence of water. To minimize the effect of microbial growth on the measurement process a means of detecting water shall be provided.

5 Testing, assessment and sampling methods

5.1 Effectiveness of leak detection kits

5.1.1 General

For the tests the following documentation shall be provided by the manufacturer:

— manual(s);

— datasheet of the parts of the leak detection kit;

— electrical diagrams of the parts of the leak detection kit;

— design and application drawings;

— parts lists of the used components including material data;

— and shall be inspected visually.

5.1.2 Disconnection of the electrical or signal cable of the measuring device

The measuring device shall be disconnected.

The disconnection of the measuring device shall result in an alarm.

5.1.3 Leak detection kit

Visual test shall be carried out that the leak detection kit consists of measuring device, evaluation device, alarm device and shut-off device for the submersible pump.

5.1.4 Measures volumetric loss

5.1.4.1 General

The test shall be carried out at a temperature of (20 ± 5) °C.

The test liquid shall be diesel according to EN 590 or transformer oil according to EN 60296.

5.1.4.2 Category A - Dynamic leak detection

5.1.4.2.1 Type 2

5.1.4.2.1.1 Test equipment

The manufacturer shall supply the algorithmic method representative of the system under test in the form of software loaded onto a computer which is capable of reading in and processing files from the standard test database previously collected from representative locations. These files shall be provided in a standard format according to Annex A and shall be accepted without any pre-processing.

The manufacturer shall state the initialization period required for the system under test, which shall not exceed 28 days.

A computer and associated data transfer peripherals.

Dispenser with digital data connection to transmit the volume withdrawn from the storage tank

5.1.4.2.1.2 Preparation

In each case, tests shall be performed following an initialization period equivalent to a maximum of 28 days operation, during which the system under test processes normal operational data without induced leaks.

A set of files shall be selected from the standard database, according to the details given in A.1.

For each type of draw-off system and fuel, the files selected shall meet the following conditions:

For each of the draw-off methods and each fuel listed in A.1, between 25 % and 75 % of the data files selected should be taken from tanks where that type of draw-off system or fuel is in use. The same data file may cover two or more uses, for example a manifolded tank using pressurized draw-off via multiple dispensers.

Leak detection systems to be tested will provide a quantitative or a qualitative output. A qualitative output will indicate a pass/fail result in accordance with Table 1.

The minimum sample sizes for data files, which shall be collected for each of these types, are:

— Systems with a Quantitative Output: ≥ 100 files (not more than 15 from the same tank);

— Systems with a Qualitative Output: ≥ 240 files (not more than 36 from the same tank).The database files shall be sorted to form an ordered data set which is divided into 5 equal groups according to the 20th, 40th, 60th and 80th percentiles of the recorded range of shade temperature. Each of the five groups shall be further divided into 3 equal sub-groups, according to the 33rd and 67th percentiles of the recorded range of tank sizes, such that sub-groupings are determined independently for each of the five groups.

For systems with a quantitative output, three files shall be selected at random from each of the 15 sub-sets, to provide a sample of 45 files for subsequent evaluation.

For systems with a qualitative output, eight files shall be selected at random from each of the 15 sub-sets, to provide a sample of 120 files for subsequent evaluation.

For example, for data collected over the ranges of shade temperature and tank capacity as defined in A.1, the files would be sorted as shown in Table 2, and *n* files selected from each sub-set as shown, where *n* = 3 for a quantitative system and *n* = 8 for a qualitative system:

Table 2 — Selection of data files according to tank capacity and ambient temperature during collection of the data

Tank Capacity	Shade Temperature				
	-5 °C to 20th Percentile	20th to 40th Percentile	40th to 60th Percentile	60th to 80th Percentile	80th Percentile to 30 °C
10 000 l to 33rd Percentile	Select *n* files at random	Select *n* files at random	Select *n* files at random	Select *n* files at random	Select *n* files at random
33rd to 67th Percentile	Select *n* files at random	Select *n* files at random	Select *n* files at random	Select *n* files at random	Select *n* files at random
67th Percentile to 50 000 l	Select *n* files at random	Select *n* files at random	Select *n* files at random	Select *n* files at random	Select *n* files at random

5.1.4.2.1.3 Procedure

A software tool shall be provided to simulate the following:

Tank leaks (constant)

Leaks from tanks are simulated as a continuous loss of product from the tank at a constant leak rate. The figure in a record representing the volume of stored product is reduced by a value equivalent to the quantity of product that would be lost at the specified rate during the time period between the record and its predecessor. The simulated losses for all previous time periods are accumulated and the total subtracted from the figure representing stored volume. These accumulated losses are also carried forward through each delivery event such that the subtracted figure increases monotonous.

Therefore, the volume figure, v_i, of the *i*th record is replaced by v_i', calculated according to Formula (1):

$$v'_i = v_i - \sum_{j=1}^{i} \left(t_j - t_{j-1} \right) R \qquad (1)$$

where

R = simulated leak rate in litre per hour;

t_j = time stamp of *j*th record;

t_{j-1} = time stamp of predecessor to *j*th record.

Where tanks are connected via a siphon, the quantity of product corresponding to the leak over the specified time interval is divided by the number of tanks in the siphon arrangement and this quantity subtracted from the records for each of the tanks connected via the siphon.

Tank leaks (variable)

Leaks from tanks are simulated as a continuous loss of product from the tank at a variable leak rate which reduces as the quantity of stored product is reduced. The figure in a record representing the volume of stored product is reduced by a value equivalent to the quantity of product which would be lost at a rate specified for the time period between the record and its predecessor. The records in a file are divided into sets, each of which comprises all the records between one delivery and the next. Successive records in a set therefore always exhibit a decrease in stored volume. Where there are n records in a set, and the stored volume of the *j*th record is v_j, the leak rate r_j for that record is found as a function of the nominal leak rate to be simulated R, according to Formula (2):

$$r_j = \frac{n\sqrt{v_j}}{\sum_{k=1}^{n}\sqrt{v_k}} R \qquad (2)$$

Therefore, the volume figure, v_i, of the *i*th record is replaced by v_i', calculated according to Formula (3):

$$v'_i = v_i - \sum_{j=1}^{i} \left(t_j - t_{j-1} \right) r_j \qquad (3)$$

The simulated losses for prior periods are accumulated and similarly subtracted from the figure representing stored volume. These accumulated losses are also carried forward through each delivery event such that the subtracted figure increases monotonous.

Where tanks are connected via a siphon, the quantity of product corresponding to the leak over the specified time interval is divided by the number of tanks in the siphon arrangement and this quantity subtracted from the records for each of the tanks connected via the siphon.

Pipe leaks (suction and pressurized draw-off)