BRITISH STANDARD

BS EN 12817:2010

LPG Equipment and accessories — Inspection and requalification of LPG tanks up to and including 13 m³

ICS 23.020.30

National foreword

This British Standard is the UK implementation of EN 12817:2010. It supersedes BS EN 12817:2002 and BS EN 12818:2002 which are withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PVE/19, LPG containers and their associated fittings.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

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English Version

LPG Equipment and accessories - Inspection and requalification of LPG tanks up to and including 13 m³

Équipements et accessoires GPL - Inspection et requalification des réservoirs de capacité inférieure ou égale à 13 m³ pour gaz de pétrole liquéfiés (GPL)

Flüssiggas-Geräte und -Ausrüstungsteile - Überprüfung und erneute Qualifizierung von Behältern für Flüssiggas (LPG) mit einem Fassungsraum bis einschließlich 13 m³

This European Standard was approved by CEN on 4 December 2009.

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Foreword

This document (EN 12817:2010) has been prepared by Technical Committee CEN/TC 286 “Liquefied petroleum gas equipment and accessories”, the secretariat of which is held by NSAI.

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of an identical text or by endorsement, at the latest by July 2010, and conflicting national standards shall be withdrawn at the latest by July 2010.

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.

Users of this standard, prepared in the field of application of Article 118A of the EC Treaty, should be aware that standards have no formal legal relationship with Directives that may have been made under Article 118A of the Treaty. In addition, national legislation in the Member states may contain more stringent requirements than the minimum requirements of a Directive based on Article 118A. Information on the relationship between the national legislation implementing Directives based on Article 118A and this EN may be given in a national foreword of the national standard implementing this EN.

This document supersedes EN 12817:2002 and EN 12818:2002.

The main modifications concern the following:

— merging of two European Standards: EN 12817:2002 and EN 12818:2002;

— improvement of Annex C which becomes normative;

— a new clause: Clause 2, Normative references.

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, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

Periodic inspection and requalification regimes for LPG tanks up to and including 13 m^3 have developed in various countries in different ways that range from defined to variable inspection periods with requalification regimes achieved by various methods. This European Standard for periodic inspection and requalification is based on European countries' legislation and codes of practice and industry codes of practice. In addition, use of LPG in different applications has encouraged the industry to approach the requirements for routine periodic inspection and requalification in different ways for each application.

This European Standard calls for the use of substances and procedures that can be injurious to health if adequate precautions are not taken. It refers to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

It has been assumed in the drafting of this European Standard that execution of its provisions is entrusted to appropriately qualified and experienced people.

1 Scope

This European Standard specifies requirements for:

a) routine inspection, periodic inspection and requalification of fixed LPG storage tanks of sizes from 150 l up to and including 13 m^3, and associated fittings;

b) marking tanks and/or keeping records, as appropriate, as a result of routine inspection, periodic inspection and requalification.

This European Standard excludes refrigerated storage.

2 Normative references

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

EN 1330-9, *Non-destructive testing — Terminology — Part 9: Terms used in acoustic emission testing*

EN 13477-1, *Non-destructive testing — Acoustic emission — Equipment characterisation — Part 1: Equipment description*

EN 13477-2, *Non-destructive testing — Acoustic emission — Equipment characterisation — Part 2: Verification of operating characteristic*

EN 13554, *Non-destructive testing — Acoustic emission — General principles*

EN 14584, *Non-destructive testing — Acoustic emission — Examination of metallic pressure equipment during proof testing — Planar location of AE sources*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
periodic inspection
external inspection of the visible parts of a tank and its fittings

3.2
routine inspection
external inspection of the visible parts of a tank and its fittings, carried out more frequently than periodic inspections

3.3
requalification
inspection/test carried out at intervals, typically at the time of a periodic inspection, in order to confirm that a tank is fit for a further period of service

3.4
competent body
person or corporate body, defined by a national competent authority, that, by appropriate qualification, training, experience, and resources, is able to make objective judgements related to inspection and testing of pressure equipment in LPG service

3.5
competent person
person who, by qualification, training, experience, and resources, is able to make objective judgements related to inspection and testing of pressure equipment in LPG service

3.6
national competent authority
organization, recognized or appointed by a member state, that oversees safe operation of LPG pressure equipment

3.7
written scheme
document, prepared by a competent body, containing inspection information

3.8
commissioning
preparation for safe service

3.9
decommissioning
removing from service and safe preparation for inspection/test

3.10
Liquefied Petroleum Gas
LPG
mixture of predominantly butane or propane with traces of other hydrocarbon gases classified in accordance with UN number 1965, hydrocarbon gases mixture, liquefied, NOS or UN number 1075, petroleum gases, Liquefied

NOTE In some countries, UN numbers 1011 and 1978 may also be designated LPG.

4 Safety

4.1 Safety precautions

Appropriate safety precautions shall be taken during decommissioning, commissioning and inspection/requalification of a tank and its fittings.

4.2 Unsafe conditions

Any unsafe condition observed by a competent person on the site of an LPG storage tank shall be reported to the person responsible for safe operation of the tank/site, as appropriate, and action taken.

4.3 Leaks

Any leak discovered from the tank or its fittings shall be reported immediately to the person responsible for safe operation of the tank.

Action to make a tank or its fittings safe shall be taken by a competent person.

NOTE Methods for detecting leaks include:

— visual inspection;

— smell;

— listening;

— use of gas detectors.

5 Written scheme

5.1 Each tank and its fittings shall be included in a written scheme taking into account the requirements of Clauses 6 to 8.

5.2 If duties are shared between different parties, the written scheme shall clearly identify the respective areas of responsibility.

5.3 Intervals between inspections shall be determined by consideration of the following:

— the design specification of the tank and its equipment;

— the corrosion protection system on the tank;

— the system used to ensure that the LPG quality conforms to its specifications/standards, and that it does not contain components damaging to the material of the tank or its fittings;

— the level of control over the filling and maintenance of the tank.

NOTE The maximum period between requalifications should not normally be greater than 20 years, and if conditions are not satisfactory the period should be reduced.

5.4 The written scheme shall contain the following information:

— the maximum interval between inspections;

— the parts to be inspected;

— the nature of the inspection;

— the critical parts that, if modified or repaired, shall be inspected by a competent person/body before they can be put back into service;

— the requirements for pressure relief valves (see 7.5.1);

— the name of the competent body preparing the written scheme;

— the date of the preparation of the written scheme.

6 Tank inspection and requalification

6.1 Routine inspection

6.1.1 Each tank and its fittings shall be routinely inspected at intervals defined in the written scheme.

6.1.2 An inspection or exception report shall be produced if repairs are required.

6.1.3 Routine inspections shall include visual inspections at the time of filling the tank.

6.1.4 Routine inspections shall include 7.1, 7.2, 7.3, 7.4, 7.5.2, 7.5.4, 7.7 and 7.11.

6.2 Periodic inspection

6.2.1 Each tank and its fittings shall be periodically inspected at intervals defined in the written scheme.

6.2.2 Periodic inspections shall include 6.1.4, 7.5.1, 7.5.3, 7.6, 7.8, 7.9 and 7.10.

6.2.3 For overground LPG tanks, a visual inspection of external surfaces shall be carried out (see Annex A). If tanks are provided with fixed passive fire protection, techniques described in Annex A are unsuitable. The written scheme shall specify alternative techniques to those specified in Annex A to ensure that no corrosion occurs on the external surface of the tank.

6.3 Requalification

6.3.1 Requalification for overground LPG tanks

Requalification intervals shall be specified in the written scheme. Requalification shall include 7.5.1 and conform to either:

a) individual requalification of each tank, including an external visual inspection and at least one of the following:

   1) an internal visual inspection (see Annex A);

   2) a hydraulic pressure test (see Annex B);

   3) an acoustic emission test (see Annex C);

   4) thickness checks (see Annex D);

   5) other method equivalent to any of the above;

b) requalification of a production batch by sampling, for serially produced tanks (see Annex E).

Sample tanks should be subjected to an external visual inspection (see Annex A), and to the following tests before any repair or refurbishment is carried out:

c) an internal visual inspection (see Annex A); and

d) a hydraulic pressure test (see Annex B); and

e) an ultrasonic thickness test (see Annex D); and

f) an X-ray or ultrasonic check on welds, comparable to inspections carried out at the time of manufacture;

or

g) an acoustic emission test (see Annex C).

6.3.2 Requalification for underground LPG tanks

6.3.2.1 Re-qualification intervals shall be specified in the written scheme. Re-qualification shall include 7.5.1 and conform to either 6.3.2.2 or 6.3.2.3.

6.3.2.2 Individual requalification of each tank shall include at least one test from group 1 and one from group 2 of Table 1.

Table 1 — Requalification tests

Group 1	Group 2
Internal visual inspection (see Annex A)	External visual inspection (i.e. excavation)
Hydraulic pressure test (see Annex B)	External monitoring by camera, etc. (see Annex F)
Acoustic emission test (see Annex C)	Cathodic protection monitoring (see Annex F or Annex G)
Ultrasonic thickness test (see Annex D)	Moisture detection (see Annex H)
Other equivalent method	

6.3.2.3 Requalification of a production batch of tanks by sampling shall be according to a sampling method agreed by a competent body (an example of a sampling method is given in Annex E).

Tanks from the sample which are returned from customers, shall be submitted to the following tests before any repair or refurbishment:

— an external visual inspection (see Annex A).

Plus one or more of the following tests as required by the written scheme:

— an internal visual inspection (see Annex A);

— a hydraulic pressure test (see Annex B);

— an ultrasonic thickness test (see Annex D);

— an X-ray or ultrasonic check on welds, comparable to inspections carried out at the time of manufacture.

The other tanks from the sample, selected at random in the production batch, shall be submitted to an acoustic emission test on site (see Annex C).

6.3.3 Commissioning

At commissioning, leak checks shall be carried out at connections. Gaskets that have been removed when breaking connections shall not be reused.

7 Inspection of tank and tank fittings

7.1 Tank

Overground tanks shall be checked for external corrosion or visible damage. If tanks are provided with fixed passive fire protection the techniques described in Annex A are unsuitable. The written scheme shall specify alternative techniques to those specified in Annex A to ensure that no corrosion occurs on the external surface of the tank.

For underground tanks, only the visible part of the tank shall be checked for external corrosion or visible damage.

7.2 Tank fittings and immediate pipework

The fittings and immediate pipework shall be inspected for the following and rectified as necessary:

— corrosion;

— damage;

— inoperative or leaking filler valves;

— worn or damaged filler valve thread or connection;

— damaged pressure relief valve;

— inoperative fixed liquid level gauge.

7.3 Valve cover

There shall be a check that valve covers, if fitted, are in place, undamaged, and able to be locked.

7.4 Bonding

7.4.1 The electrical bonding between the tank and earth point shall be visually checked, where fitted.

7.4.2 There shall be a check that the road tanker bonding tag is undamaged (if applicable).

7.5 Pressure relief valve

7.5.1 There shall be either:

a) a test of the set pressure of the pressure relief valve and, for an external pressure relief valve, a check on the condition of the spring; or

b) the pressure relief valve shall be replaced with a new or reconditioned valve if required.

WARNING — Do not remove a pressure relief valve from a pressure relief valve manifold or check-device while a tank is under pressure, unless a serviceable replacement is available for immediate fitting. Do not remove a pressure relief valve mounted in a tank under pressure unless the type and construction of the check device can be identified and the manufacturer's instructions for safe removal are complied with. A check device shall include positive means of confirming that the check device has closed before the pressure relief valve is unscrewed to an otherwise dangerous stage.

7.5.2 The pressure relief valve drain hole shall be checked to ensure it is clear.

7.5.3 Stack pipes shall be inspected for corrosion. The pressure relief valve shall also be externally inspected if corrosion is found in the stack pipe.

7.5.4 There shall be a check that rain caps are present and in good condition.

7.6 Pressure gauge

The pressure gauge, if fitted, shall be checked against a test gauge or replaced.

7.7 Contents gauges

Gauging devices or contents gauges that bleed to the atmosphere (e.g. rotary tubes, fixed tubes or slip tubes) shall be tested when filling the tank. Other types of contents gauges shall be checked as required (e.g. during product transfer to or from the tank).

7.8 Shut-off valves

Shut-off valves shall be tested for correct function.

WARNING — When checking the function of a shut-off valve, do not shut off the gas supply unless the user has been informed. Do not restore the gas supply before checking that the appliance valves are closed.

Blanked or plugged liquid phase valves shall be checked for external leakage.

7.9 Studs, bolts, nuts, and washers

Studs, bolts, nuts, and washers shall be checked for damage or severe corrosion and replaced if required.

7.10 Corrosion protection system

Any check required for the selected corrosion protection system, as detailed in the written scheme, shall be carried out.

7.11 Piers and foundations for overground tanks

The condition of piers and foundations shall be checked to ensure that they are sound with no visible damage or uneven settlement. Anchoring bolts shall be visually inspected for deterioration, where fitted and accessible.

8 Competence

NOTE Definitions of the competence to do inspections/requalification per national legislations should be considered.

8.1 Routine inspection

Persons shall be deemed competent to carry out routine inspections if they have received appropriate training to carry out the requirements of 6.1 and to prepare an inspection report.

8.2 Periodic inspection

Persons shall be deemed competent to carry out periodic inspections if:

— they are competent to carry out routine inspections (see 8.1); and

— they are part of an inspection team with the appropriate background, training and qualification, or have worked with or within the LPG industry, performing the relevant task, and have a good general knowledge of LPG and its operating environment.

The relevant attributes shall be documented.

8.3 Requalification

Persons shall be deemed competent to requalify a tank if they possess detailed knowledge of the technique(s) used in requalification with relevant training and certification.

9 Records

9.1 Tank data

If the tank identification plate or tag is illegible, it shall be cleaned, repaired or replaced as appropriate.

All information on the tank data plate or tag or documentation shall be updated, as appropriate, after periodic inspection or requalification.

9.2 Reports

A system shall be in place to ensure that routine inspections are carried out in accordance with the written scheme.

A report shall be produced if a tank passes a periodic inspection or requalification.

If a tank fails a periodic inspection or requalification, a report shall be prepared as part of a formal follow-up system. Decisions whether to exchange a tank or repair a fault on site shall be taken by the person responsible for safe operation of the tank in consultation with the competent body.

NOTE An example of a test report form used for routine inspections or periodic inspections and requalification is given in Annex J.

Annex A
(informative)

Visual inspection

A.1 Internal and external visual inspections

The aim of internal and external visual inspection is to detect surface defects on the tank shell, which may require the tank to be rejected from service, including:

— deterioration of coating (where visible for underground tanks);

— corrosion;

— cracks, dents, gouges, lamination and bulges;

— inclinations and subsidence.

A.2 Inspection techniques

A.2.1 External visual inspection

External surfaces should be clean and dry. The condition of the coating should be checked and a note made of any corrosion, imperfections, or mechanical damage.

The inspection should be carried out visually, using, if required, the following:

— a beam of light directed along the surface of the tank to indicate imperfections by shadow;

— a straight edge placed along the surface to show the extent of a defect;

— a depth gauge to determine the depth of corrosion, dents or gouges;

— a magnifying glass for detailed inspections;

— a mirror.

A.2.2 Internal visual inspection

The surfaces should be clean, dry and free from foreign matter.

Surfaces should be checked for corrosion and mechanical damage using an endoscope, camera or other means.

If it is possible for a person to enter the tank, then the inspection techniques detailed in A.2.1 can be used.

A.3 Records

Defects, including manufacturing problems, should be noted in the tank record. Deterioration in recorded defects should be assessed at the next inspection.

A.4 Additional inspection

A.4.1 Additional inspections can be required to confirm the suitability of a tank for further service.

A.4.2 Written instructions for additional inspections of a tank should be prepared by a competent person. Written instructions and results of additional inspections should be kept in the tank record.

Annex B
(informative)

Hydraulic pressure test

B.1 The hydraulic pressure test should be performed in accordance with this annex. All fittings should be removed before testing.

Water should normally be used as the test fluid. During the test, the water temperature should not fall below 7 °C.

The tank should be properly vented before the test pressure is applied to prevent formation of air pockets.

B.2 The test pressure for the tank should be as specified on the data plate or documentation, or as required by the competent person.

B.3 The pressure in the tank should be gradually increased up to the test pressure, and the tank isolated from the pressurising pump. The pressure in the tank should be maintained for sufficient time to assess the tank, but not less than 10 min.

B.4 If no significant reduction in pressure is observed in the tank during the test, and there are no signs of general plastic yielding or leaks from the pressure envelope, the tank should be deemed to pass the test.

B.5 The tank should be carefully drained, and dried out if required.

B.6 Gaskets, bolts, etc. should be changed as appropriate after the test.

Annex C
(normative)

Acoustic emission testing

C.1 Scope

This annex specifies the minimum requirements for the test equipment, the type and sequence of loading, data acquisition and data evaluation, for the performance of an AT (acoustic testing) on LPG vessels up to a volume of 13 m^3.

NOTE Further requirements per national regulations should be considered.

These minimum requirements cover all types of LPG vessels, including those produced with juggle joints, both above and under ground.

The purpose of the AT is to detect and evaluate indications of flaws within the vessel. The tests can be performed on-site and the pressurisation may be performed with LPG.

C.2 Testing procedure

A testing procedure according to EN 13554 for AT shall be developed.

C.3 Instrumentation

C.3.1 Sensors

The resonant frequency of the sensors shall be in the range of 70 kHz to 180 kHz, except for bitumen coated underground vessels where the range shall be 30 kHz to 80 kHz.

C.3.2 Acquisition and evaluation system

The AE (acoustic emissions) acquisition and evaluation system shall be checked and maintained in accordance with EN 13477-1 and EN 13477-2.

The AE acquisition and evaluation system shall be able to acquire, record and evaluate all data to meet the requirements of C.6.1.

C.4 Testing

C.4.1 Test instruction

The written AT test instruction shall conform to EN 14584. The values for stop, acceptance and rejection criteria of the tank shall be included in the test instruction. The test instruction shall be delivered to the owner/user and the supervision body, where required, before the test is performed.

C.4.2 Safety precautions

The tank shall not be overfilled.

If the acoustic signals indicate a leak, it shall be fixed before proceeding.

The test pressure equipment shall have an emergency shut-down system to stop the pressurisation and to initiate rapid depressurisation of the tank.

When pressurising a tank containing LPG, if the test pressure is to exceed the maximum allowable pressure P_S then in addition:

a) the written agreement of the tank manufacturer should be obtained or be assessed by a competent person;

b) the safety accessories should be blanked and replaced by accessories set at a convenient pressure;

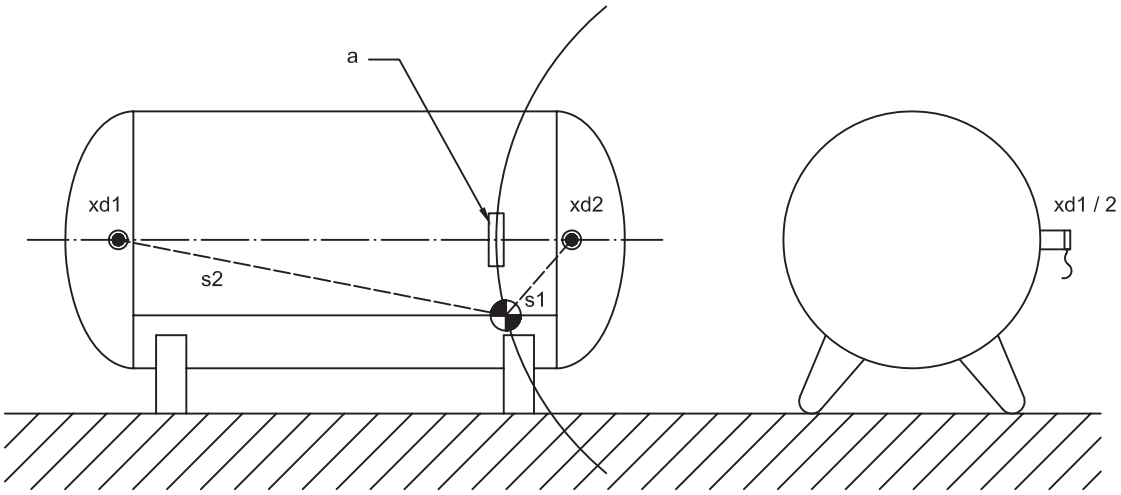
c) the pressure accessories shall be able to withstand the test pressure.

The test shall not be carried out at a low external temperature (e.g. 0 °C) in order to avoid re-condensation in the pressurisation line.

C.4.3 Sensor location

C.4.3.1 Above ground tanks

As a minimum, two sensors shall be used, one at each end of the cylindrical part of the tank in order to allow the testing organisation to apply linear location.



Key

xd1, xd2 sensor position
s_1,s_2 travelling path
a virtual source between the sensors

Figure C.1 — Sensor location on above ground storage tank

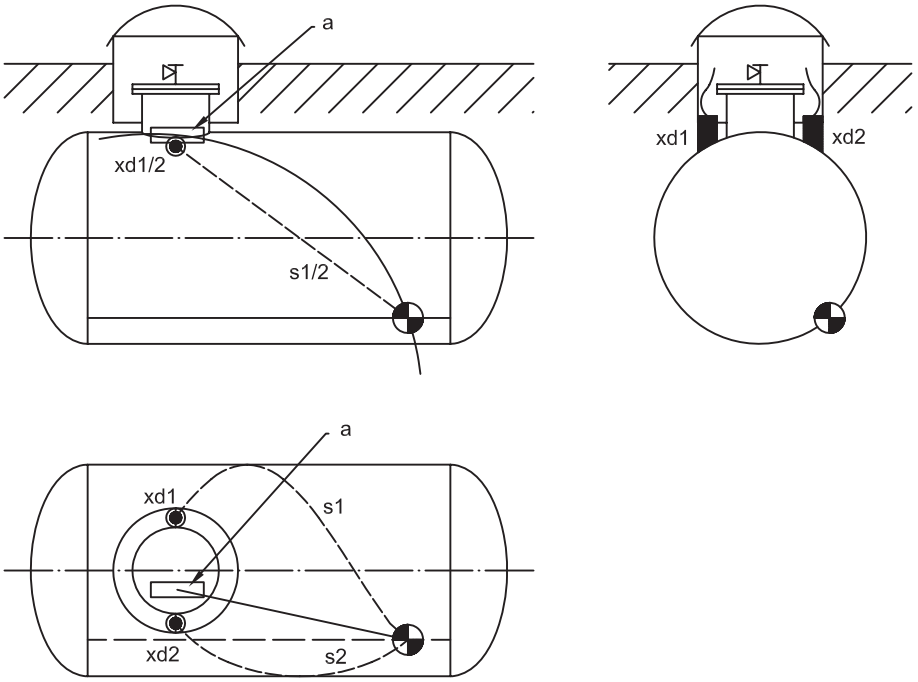
The maximum sensor spacing shall not exceed that as defined in EN 14584.

C.4.3.2 Underground tanks

For LPG vessels up to a length of 5 m and a diameter of 1,5 m for epoxy coated or enclosed in a protective envelope and a length of 4 m and a diameter of 1,2 m for bitumen coated it is normally sufficient to apply two sensors within the valve chamber. The longest travelling path of the acoustic wave, which shall reach both sensors with sufficient peak amplitude, shall be taken into account in accordance with EN 14584.

This shall be verified using an identical vessel and coating situated above ground containing the appropriate level of liquid.

The distance between the sensors in the valve chamber shall be as large as possible.



Key

xd1, xd2 sensor position
s_1,s_2 travelling path
a virtual source between the sensors

Figure C.2 — Sensor location on underground tanks with manhole

This allows AE event discrimination from background noise based on Δt where Δt (delta t) is the measurement of arrival time difference in accordance with EN 1330-9.

NOTE Δt – clustering is a concentration of time dependent correlated acoustic events within a timeframe. This clustering allows the tank to be divided into several rough location clusters.

C.4.4 Pressurisation

The vessel shall be monitored for a period of 5 min before pressurisation in order to evaluate any emission resulting from active corrosion.

The vessel shall be pressurised to a minimum of 10 % above the highest service pressure reached during the last service period, and should not exceed 110 % of the maximum allowable pressure P_S.

NOTE 1 Some national regulations do not permit pressurisation to exceed the P_S value, see C.5.2.

Pressurisation shall be at a constant rate of less than 0,3 bar/min.

Once the maximum pressure is reached, pumping shall cease and the pressure is held for at least 5 min.

NOTE 2 Pressure decays due to temperature changes are acceptable.

C.5 Data evaluation and analysis

C.5.1 Evaluation criteria

The criteria shall be based upon the following parts:

a) acquisition of a defined number N_1 of AE bursts (within the range of Δt – values used to identify AE events from the vessel), above a high specified peak amplitude value A_1;

b) acquisition of a defined number N_2 of AE bursts (within the range of Δt – values used to identify AE events from the vessel), above a low specified peak amplitude value A_2;

c) acquisition of a defined number of N_3 of AE bursts (within the range of Δt – values used to identify AE events from the vessel), above the specified peak amplitude value A_2, 2 min after the beginning of the hold period at the end of the test;

d) acoustic emission activity and/or energy rate as a function of the pressure;

e) for LPG vessels containing juggle joints a more complex evaluation criteria is required. This should be based on evaluation criteria, combined to produce an evaluation factor C, which takes into account at minimum:

   1) number of the AE bursts within a Δt – cluster;

   2) AE peak amplitude and/or energy of the AE bursts within a Δt – cluster;

   3) AE burst activity within a Δt – cluster over the test period and/or shorter time and/or pressure periods sequentially distributed over the test time.

The values for the peak amplitudes A_1 and A_2 shall take into account wave attenuation for the maximum propagation distance between source and sensors in the vessel.

C.5.2 Real time control and stop criteria

The real time control and stop criteria shall be specified in the test instruction. It shall be based on:

a) the evaluation criteria of C.5.1 (a), b) and d));

b) if the calculation of the evaluation factor C of C.5.1, e) is done automatically in real time, this factor shall also be included into the stop criteria and may replace the evaluation criteria b) and d).

C.5.3 Post analysis

The values of the evaluation criteria in C.5.1 shall be determined and documented. The post analysis may be performed off-site.

C.5.4 Vessel grading

The vessel shall be graded according to the values of the evaluation criteria (6.3) in comparison with the rejection criteria defined in the written test instruction (5.1).

C.6 Data storage and reporting

All test data for the vessel shall be kept on a database to assist in establishing the acceptance criteria.

The test report shall include at minimum:

— tank identification;

— test date;

— the test pressure (start and end of acquisition);

— pressurisation rate;

— the value of the evaluation factor C;

— the number of AE events above A_1 and A_2, if N_1 and/or N_2 or N_3 were exceeded.

The test report shall state if the tank has passed or failed the AE acceptance or rejection criteria.

Annex D
(informative)

Ultrasonic thickness test

D.1 General

Trained persons, with demonstrated competence with ultrasonic thickness testing equipment and interpretation of results, should carry out the ultrasonic thickness test.

D.2 Apparatus setting

The ultrasonic testing apparatus should be set up in accordance with the manufacturer's instructions.

D.3 Control measurement

The tank nominal thickness (control measurement) should be established by either:

— measuring the thickness in at least three places on the top dead centre of the tank, and taking the average; or

— using the tank thickness as specified in the original drawings.

Measurements should also be made just below the knuckle radius at each end of the tank.

D.4 Shell thickness measurements

Shell thickness measurements are taken:

— at 300 mm intervals along the shell and at 30° below top dead centre of each side;

— at 90° below top dead centre and 20° above bottom dead centre and readings are recorded on the report.

D.5 End thickness measurements

End thickness measurements are made at 150 mm intervals and at the same angular pattern as in D.4 on the tank ends and readings are recorded on the report.

D.6 Interpretation

If any reading is more than 10 % thinner than the control measurement (see D.3), the surrounding area is measured at 25 mm intervals radiating outwards and the thin area is marked on the tank surface.

NOTE Lamination defects are normally indicated by an abrupt change in thickness at the edge of the thin area. Corrosion defects are normally indicated by a gradual return to full thickness away from the corroded area.

D.7 Rejection criteria

Rejection criteria should be decided by a competent person and should take into account the original design, interval between successive tests, and previous test results if applicable.

Annex E
(informative)

Assessment of tanks by sampling

E.1 General

The aim of the assessment is to ascertain the condition of a homogeneous batch of series produced tanks by testing a representative sample.

E.2 Homogeneous batch

A batch should be considered homogeneous if all the tanks are as follows:

— manufactured in the same year;

— manufactured at the same place;

— of the same grade and quality of steel;

— of the same dimensions and nominal capacity, within tolerance limits;

— of the same design code or standard;

— of the same method of manufacture;

— of the same design pressure;

— of the same nominal thickness.

Manufacturer's documents should be produced to demonstrate homogeneity.

E.3 Selection of samples

Break the batch down into sample groups (starting with group 1, then group 2, etc., until the batch is fully divided up), in accordance with Table E.1.

Table E.1 — Number of tanks per sample group from homogenous batch

Group number	Number of tanks in group	Sample rate	
		Normal rate %	Reduced rate [a] %
1	100	24	12
2	100	20	10
3	200	16	8
4	400	12	6
5	800	8	4
6	1 600	4	2
7	rest of sample	2	1

[a] The reduced sample rate applies to:

— batches of tanks of which the characteristics are identical (see E.2) to a batch of tanks manufactured in the previous year and that have passed the requalification procedure;

— batches of tanks that have already passed a requalification procedure.

E.4 Sample selection

Tanks making up the sample should be selected at random. Tanks returned by customers should be considered chosen at random, provided that all returned tanks are inspected, up to 80 % of the sample size.

E.5 Inspection period

Re-qualification inspection of a batch can start two years before the re-qualification year. At least 20 % of the sample should be tested during the re-qualification year, and the entire sample before the re-qualification date.

E.6 Presentation of results and decisions

All results of inspections and tests pertaining to each batch should be presented to the competent body before the end of the re-qualification year.

E.7 Pass criteria

If all tanks pass the inspections and tests, the batch can continue in operation.

If one or more of the tanks do not meet the re-qualification criteria then further investigation of the batch should be carried out as agreed with the competent body or all of the tanks of the batch should be tested individually.

E.8 Example calculation of a sample

Table E.2 shows how a batch of 9 600 tanks is divided into samples in accordance with E.3.

Table E.2 — Calculation of a sample

Group number	Number of tanks in group	Cumulative number of tanks	Percentage sampled %	Number of tanks in sample
1	100	100	24	24
2	100	200	20	20
3	200	400	16	32
4	400	800	12	48
5	800	1 600	8	64
6	1 600	3 200	4	64
7	6 400	9 600	2	128
Total				380

Annex F
(informative)

External monitoring by camera for underground tanks

F.1 General

This type of inspection can only be applied to underground tanks that are enclosed in a protective envelope. The protective envelope is designed to allow access to a remotely operated camera or other suitable means of inspection.

F.2 Inspection procedure

F.2.1 The first inspection should be carried out between six months and 18 months after installation of the tank.

F.2.2 There should be a check that there is no flammable atmosphere within the protective envelope.

F.2.3 The inspection should include:

a) a check that there is no excessive accumulated water below the tank within the protective envelope;

NOTE The tank should not be in contact with water.

b) recording the surface condition of the full length of the tank using the camera.

F.3 Interpretation of results

F.3.1 Excessive water or any flammable atmosphere or corrosion found within the protective envelope should be assessed by a competent person and corrective action taken.

F.3.2 If corrective action is taken for excessive water or a flammable atmosphere, after ensuring any gas leak is repaired a further check should be made within six months.

F.3.3 If corrective action is not successful (as decided by the competent person) the tank should be replaced.

F.3.4 If no excessive water, flammable atmosphere or corrosion is discovered, the tank should be certified for a further period of operation as defined in the written scheme.

F.4 Records

The certificate (F.3.4) should be kept in the tank record together with the complete camera record (F.2.3, b)).

Annex G
(informative)

Monitoring cathodic protection with sacrificial anodes for underground tanks

G.1 General

The cathodic protection system should be monitored by a competent person (see EN 15257).

G.2 Records

Details of the cathodic protection system should be retained with the tank records.

G.3 Procedure

G.3.1 An initial check conforming to G.4 should be carried out in accordance with the written scheme, normally between six months and 18 months after installation.

G.3.2 Subsequent checks should be carried out at intervals as defined in the written scheme.

This interval should not normally be greater than three years.

G.3.3 The electrical connections of the cathodic protection system and the insulating joint, if fitted, should be inspected.

G.3.4 The galvanic current should be measured in accordance with G.4.

G.3.5 The potential difference of the tank to the reference electrode should be measured in accordance with G.5.

G.4 Measurement of the galvanic current

G.4.1 The current delivered by each anode linked to the tank should be measured.

G.4.2 If there is no current between the anodes and the tank, the electrical connections of the anodes should be checked. If current cannot be re-established, advice should be sought.

G.4.3 If there is current, the cathodic protective system is operating, and the relevant competent person should assess the residual lifetime of the anodes by reference to previous data.

G.5 Measurement of the potential difference of the tank to the reference electrode

G.5.1 The potential difference of the tank to the reference electrode should be measured without interrupting the anode connections.

G.5.2 The potential difference between the system (tank and anodes connected together) and a reference $Cu/CuSO_4$ electrode (placed in the ground in one or more positions), should be measured as follows.

If the potential difference of the cathodic protection system U is between - 1 700 mV and - 850 mV, the tank can be protected against corrosion.

If U is greater than - 850 mV, the cathodic protection system is not functioning properly, and the following procedure should be followed:

a) check that the wires to the connector box are properly connected;

b) check that one or more cables have not been cut;

c) if a) and b) are satisfactory, check the electrical insulation of the tank relative to the piping;

d) check the reference electrodes and the measuring instrument.

If the potential difference of the cathodic protection system U cannot be restored in the range between - 1 700 mV and - 850 mV, the competent person should be consulted.

If the potential of the cathodic protection system U cannot be restored after consulting the competent person, the installation should be shut down and the cathodic protection replaced and/or the tank excavated for further investigation.

G.5.3 If the potential difference of the tank to the reference electrode is measured when switching off the current, then it can be established whether all parts of the tanks are sufficiently protected. The following procedure should be carried out.

The potential difference between the tank and a reference electrode of $Cu/CuSO_4$ (placed in the ground), should measured immediately after switching off the protection current.

NOTE 1 This method prevents from including in the measures the ohmic drop due to the protection current between the tank and the anodes.

NOTE 2 The measured value should drop after interruption of the current and then stay briefly constant (usually for less than 1 s).

If the value at this time is - 850 mV or less, the cathodic protection system is functioning, and the tank is fully protected against corrosion.

If the value at this time is greater than - 850 mV, the tank is not properly protected and further investigations should be carried out.

G.6 Results

Results should be presented to a competent person so that the competent person can verify the effectiveness of the cathodic protection and ensure that the residual lifetime of the anodes is sufficient.

If corrective action is taken on the cathodic protection system, a further check should be made within 18 months.

Annex H
(informative)

Monitoring cathodic protection by impressed current for underground tanks

H.1 General

The condition of the tank coating can be checked by assessing its isolation resistance and measuring the current through the coating under switched-on potential without digging up the tank.

H.2 Apparatus

The following apparatus should be used to carry out the assessment:

a) $Cu/CuSO_4$ electrode, with an electromotive force of (- 316 ± 10) mV. $CuS0_4$ solution should be saturated (min. 20 g crystals to 100 ml water);

b) potentiometer, with an internal resistance of at least 1 MΩ and an error limit of maximal 1 %;

c) ammeter, with a low internal resistance and an error limit of maximal 2 %;

d) measurement cables, with a minimum cross sectional area of 1,5 mm^2;

e) adjustable d.c. supply;

f) stainless steel earthing pin.

H.3 Conditions

The tank should be electrically isolated from the parts of the installation above ground.

H.4 Isolation resistance of the coating

H.4.1 Procedure

The cathodic protection system should be disconnected.

The negative pole of the d.c. supply should be connected to the earthing pin (which is located at least 10 m from the tank).

The positive pole should be connected to the tank.

The tank should be connected via the ammeter to the $Cu/CuSO_4$ electrode. The electrode should be placed in the ground near the middle of the tank so that the tank is between the earthing-pin and the electrode.

The potentiometer should be connected across the d.c. supply.

The potential should be adjusted to - 1 500 mV and the current measured.

H.4.2 Calculation

The potential difference U_c over the coating is:

$$U_c = U_s - U_n$$

where

U_s is the supplied potential in millivolts (mV);

U_n is the electrochemical potential of the steel in millivolts (mV).

The specific current through the coating I_c is:

$$I_c = I_m / A$$

where

I_m is the measured current at - 1 500 mV, in milliamperes (mA);

A is the surface area of the tank in square metres (m^2).

The isolation coating resistance R_c is:

$$R_c = U_c / I_c$$

H.5 Results

If R_c is equal to or greater than 200 kΩ/m^2, the coating is in good condition and corrosion should not occur.

If R_c is between 25 kΩ/m^2 and 200 kΩ/m^2, and there is no cathodic protection, a cathodic protection should be installed, unless the tank coating can be repaired.

If R_c is between 25 kΩ/m^2 and 200 kΩ/m^2, and there is a cathodic protection system in place, this should be checked by an expert.

If the cathodic protection system cannot achieve a potential of - 850 mV on disconnection from all tank parts, there can be defects in the tank coating that should be located and repaired (e.g. by Pearson measurement).

H.6 Checking intervals

Impressed current checks should be carried out at least every six years.

Annex I
(informative)

Corrosion monitoring by moisture and condensation detection for underground tanks

I.1 General

This type of inspection can only be applied to underground tanks that are enclosed in a protective envelope that can be continuously monitored for water.

I.2 Equipment characteristics

The equipment should be able to detect and record, with each reading, any condensation in the lower part of the tank, or ingress of water in the space between the tank and the protective envelope.

The equipment should allow verification of its correct functioning at each reading.

I.3 Monitoring

The equipment should be checked as required by the written scheme to see if any condensation or moisture has been detected.

The equipment should be checked for correct functioning by a competent person at installation and at least every three years afterwards.

I.4 Interpretation

If no condensation or moisture is detected, no action is required.

If condensation or moisture is detected temporarily, corrective action should be taken within six months, and the tank rechecked within six months of corrective action.

If permanent condensation or moisture is detected, corrective action should be taken within two months, and the tank rechecked within six months of corrective action.

If corrective action cannot remove condensation or moisture, the tank should be excavated.

Corrective action and results should be recorded in the tank record.

Annex J
(informative)

Example of an inspection and requalification report

Table J.1 gives an example of a report form that can be used for a routine inspection or periodic inspection and requalification.

Table J.1 — Static LPG tank inspection and/or requalification report

Routine inspection ☐	**Periodic inspection ☐**	**Requalification ☐**
Site address	Tank data	
Check list	Fitting details	
Visual inspection of tank, fittings and site		
Requalification Method of requalification and test/inspection results	Work done/required	
Certificate for further period of service		
Name/details of inspector	Date of inspection	

Annex K
(informative)

A-deviations

A-deviation: National deviation due to regulations, the alteration of which is for the time being outside the competence of the CEN/CENELEC Member.

This European Standard does not fall under any Directive of the EU. In the relevant CEN/CENELEC countries these A-deviations are valid instead of the provisions of the European Standard until they have been removed.

Clause	Deviation
1	**Austria:**
	Provisions for the first operating inspection and periodic inspections:
	In Austria provisions are given for the first operation inspection and periodic inspections in Austrian Federal Law concerning pressure vessels BGBl. Nr. 211/1992, §§13 and 15 (Federal Law Gazette No. 211/1992, Clauses 13 and 15) as well as in the Austrian decree on in service inspection of Pressure Equipment, BGBl. II Nr. 420/2004.
1	**Sweden:**
	In Sweden tanks shall be inspected and requalified according to the regulations in the ordinance AFS 2005:3 from the Swedish Work Environment Authority regarding Pressure Retaining Devices.
1	**France:**
	The tanks shall be inspected and requalified according to "Arrêté ministériel du 15 mars 2000 modifié relatif à l'exploitation des équipements sous pression (titres III et V)".
1	**Denmark:**
	The tanks shall be inspected and requalified according to the regulations in Order No. 100 from 31 January 2007, regarding use of pressure equipment.
1	**Germany:**
	The tanks shall be inspected and requalified according to the German Ordinance on industrial safety and health (Betriebssicherheitsverordnung, BetrSichV).

Bibliography

[1] EN 15257:2006, *Cathodic protection — Competence levels and certification of cathodic protection personnel*

[2] EN 15495:2007, *Non Destructive testing — Acoustic emission — Examination of metallic pressure equipment during proof testing — Zone location of AE sources*

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