BS EN 16753:2016

BSI Standards Publication

Gas cylinders — Periodic inspection and testing, in situ (without dismantling) of refillable seamless steel tubes of water capacity between 150 l and 3 000 l, used for compressed gases

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National foreword

This British Standard is the UK implementation of EN 16753:2016.

The UK participation in its preparation was entrusted to Technical Committee PVE/3/7, Gas containers - Gas cylinder (receptacle) operations.

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.

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EUROPEAN STANDARD

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English Version

Gas cylinders - Periodic inspection and testing, in situ (without dismantling) of refillable seamless steel tubes of water capacity between 150 l and 3 000 l, used for compressed gases

Bouteilles à gaz - Contrôles et essais périodiques sur site (sans démontage) des tubes en acier sans soudure rechargeables d'une contenance en eau de 150 l à 3 000 l, utilisés pour les gaz comprimés

Gasflaschen - Wiederkehrende Inspektion und Prüfung, im Einbauzustand (ohne Demontage), von wiederbefüllbaren nahtlosen Großflaschen aus Stahl mit einem Fassungsraum zwischen 150 l und 3 000 l für verdichtete Gase

This European Standard was approved by CEN on 15 April 2016.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (EN 16753:2016) has been prepared by Technical Committee CEN/TC 23 "Transportable gas cylinders", the secretariat of which is held by BSI.

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of an identical text or by endorsement, at the latest by December 2016, and conflicting national standards shall be withdrawn at the latest by December 2016.

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.

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.

Introduction

A number of seamless steel pressure vessels designed and manufactured in a similar way as tubes, as referred to in ADR are used for applications other than the transport of gases, e.g. Ice Breaking Emergency Evacuation Vessels (IBEEV), Diving Support Vessels (DSV), power generation, hospitals, advanced research applications and marine installations such as heave compensation systems on semi-submersible drilling rigs, etc.

This European Standard is applicable only to seamless steel pressure vessels installed in locations where attempting any removal from their containing superstructure would be hazardous or difficult or where the downtime required to remove the tube would hinder a continuous operation of a plant or service.

This European Standard provides information and procedures for the periodic inspection and testing of such refillable seamless steel vessels (tubes). Many of these vessels installed in various installations are certified by the manufacturer to meet the requirements of EN ISO 11120 and are designed to store compressed and liquefied gases. Other design standards are also in use.

An example of a similar approach to that adopted in this standard is that for compressed natural gas (CNG) cylinders installed on-board automobile vehicles which is described in ISO 19078.

This standard is intended to be used under a variety of regulatory regimes. In case of conflict, the applicable regulation takes precedence.

1 Scope

This European Standard specifies requirements for using a combination of appropriate *in situ* (without dismantling), non-destructive examination (NDE) techniques, for example visual examination, acoustic emission testing [AT] and ultrasonic testing [UT] when periodically inspecting and testing seamless steel pressure vessels (tubes) with a water capacity between 150 l and 3 000 l, used for compressed and liquefied gases for a further period of service.

This European Standard is applicable only to pressure vessels (tubes) installed in locations where attempting any removal from their containing superstructure would be hazardous, or where the downtime required to remove them would hinder a continuous operation of a plant or service.

This European Standard does not apply to pressure receptacles used for the transport of gases as described under the TPED.

This European Standard only applies to pressure vessel (tube) assemblies where the designs permit all necessary inspections stipulated.

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 1968:2002, *Transportable gas cylinders — Periodic inspection and testing of seamless steel gas cylinders*

EN ISO 9712, *Non-destructive testing — Qualification and certification of NDT personnel (ISO 9712)*

EN ISO 13769, *Gas cylinders — Stamp marking (ISO 13769)*

EN ISO 16148, *Gas cylinders — Refillable seamless steel gas cylinders and tubes — Acoustic emission examination (AT) and follow-up ultrasonic examination (UT) for periodic inspection and testing (ISO 16148)*

EN ISO 25760, *Gas cylinders — Operational procedures for the safe removal of valves from gas cylinders (ISO 25760)*

ISO 6406:2005, *Gas cylinders — Seamless steel gas cylinders — Periodic inspection and testing*

3 Terms and definitions

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

3.1
acoustic emission (AE) activity
number of bursts (or events if the appropriate conditions are fulfilled) detected during a test or part test

3.2
flow noise
acoustic emission events caused by the action of pressurizing the vessel and not by any structural flaws within it

Note 1 to entry: This can be reduced by slowing the fill rate and/or filtering out such emissions electronically within the AE recording equipment.

3.3
acoustic emission test pressure
maximum pressure at which acoustic testing is performed

3.4
working pressure
settled pressure of a compressed gas at a uniform reference temperature of 15 °C in a full gas cylinder

Note 1 to entry: See EN ISO 10286.

3.5
Kaiser effect
absence of detectable acoustic emission until the previous maximum applied load level has been exceeded

4 Operational principles

4.1 General

The periodic inspection and test shall comprise a pre-inspection site visit followed by an on-site inspection.

The maximum time interval for the periodic inspection should be as stipulated in the national regulations for the gas concerned. In the absence of such regulations, the time intervals for the gas concerned are given in Annex C. Where other organizations/institutions stipulate a shorter time interval, this shall be complied with. The applicable time interval shall be included in the written scheme of examination.

At all times, the safety of all personnel in the vicinity of the installation shall be taken into account.

The techniques used to evaluate the tube condition within the installation may include:

a) hydraulic pressure testing (see EN 1968);

b) acoustic emission testing (see EN ISO 16148);

c) internal and external visual examination (see EN 1968);

d) ultrasonic thickness survey (see EN 1968);

e) ultrasonic flaw detection (see EN 1968);

f) magnetic particle testing (see EN ISO 9934-1);

g) radiographic testing (see EN ISO 5579);

h) eddy current testing (see EN ISO 15548 (all parts));

i) hardness testing (see EN ISO 9809-1).

At the discretion of the competent person employed for the task, other appropriate test techniques may be used, e.g. dye penetrant.

Indication of any anomaly in the tube(s) under test that are revealed at the time of the *in situ* inspection shall be evaluated using a different technique to be able to quantify (location and frequency) and size any possible imperfection.

4.2 Pre-inspection site visit

Prior to any tests taking place, a pre-inspection visit to the site of the tube installation shall be undertaken to gather all the necessary information to ensure that an appropriate set of tests are performed for the installation and the suitability of the tube to be examined without dismantling.

To ensure that the installation itself and any areas of concern related to it are understood, the site owner/operator shall complete a questionnaire before the pre-inspection visit. The pre-inspection visit shall, as a minimum, identify and record:

a) the application of the tube to be examined/tested (e.g. submersible, a static storage service [offshore or on-shore], used in a diving application);

b) the manufacturing standard/specification of the tube to be examined;

c) details of the tube installation including at least:

   1) the feasibility of conducting an *in situ* test at the desired location without dismantling e.g. post hydraulic testing to ensure that all water can be eliminated (see Annex D);

   2) a listing of any applicable local regulations that apply to the *in situ* installation;

   3) the nature of the gas contained;

   4) the pressure rating(s) of the tube(s) to be examined;

   5) the pipework configuration, and its pressure rating, leading to and from the tube (if relevant);

   6) the type of any valve, pressure control device, ancillary item (e.g. pressure gauge) and their pressure ratings fitted to the tube or its pipework (if relevant);

   7) the pressure rating and relief valve setting of the compressor (if relevant);

   8) the design characteristics of the pressure vessel (tube) and associated installation to be inspected to withstand the acoustic emission test pressure/hydraulic test pressure;

   9) the environmental conditions at the test site (e.g. noise and vibration levels); and

   10) a location-based risk analysis (see Annex D).

If the collected information does not allow the use of this European Standard, such tube(s) shall not be tested and the owner informed accordingly.

4.3 On-site inspection

4.3.1 General

Having gathered and analysed the data from the pre-inspection site visit (see 4.2), the most suitable test method(s) for the particular tube installation under consideration shall be selected. The selected methods shall form the basis of a written scheme of examination for the installation being inspected.

At all times the inspection work shall be carried out in accordance with the appropriate written procedures(s) for the test(s) to be performed.

Periodic inspection and testing shall comprise, as a minimum, of:

a) a visual examination (see 4.3.2) of all accessible external surfaces, internal surfaces and an acoustic emission test (see 4.3.3) coupled with any other tests deemed necessary; or

b) a visual examination (see 4.3.2) of all accessible external surfaces, internal surfaces and a hydraulic test (see 4.3.4) coupled with any other tests deemed necessary.

If it is found that the tube surface coating is unsatisfactory for a further period of use, it shall be brought to the attention of the tube owner for further appropriate action to remedy the situation.

Once the tube(s) has failed one of the above mentioned tests, none of the other test methods shall be applied to approve the tube(s).

If at any stage of the inspection process the valve/plug/adaptor/pressure control device within the tube needs to be removed, this shall be done in accordance with the requirements of EN ISO 25760.

4.3.2 Visual examination

All external visual examinations (see Annex A) shall be performed in accordance with the requirements of EN 1968:2002, Annex C (additional information can be found in ISO/TR 16115).

All internal visual examinations shall be performed in accordance with the requirements of EN 1968:2002, Annex C (additional information can be found in ISO/TR 16115).

All signs of corrosion and any form of mechanical damage shall be carefully investigated.

Where necessary, additional equipment (e.g. a video camera or an endoscope) shall be used to help clarify and interpret the initial observations.

4.3.3 Acoustic emission testing

AT shall be carried out in accordance with the requirements of EN ISO 16148 (an examination procedure using AT is described in Annex B).

4.3.4 Hydraulic testing

Hydraulic testing shall be carried out in accordance with the requirements of EN 1968:2002, 10.2.

4.3.5 Supplementary tests

Where there is doubt about the type and/or severity of any imperfection identified by the tests in 4.3.2 to 4.3.4, additional test(s) shall be conducted to supplement or clarify the results obtained (e.g. UT, magnetic particle testing, radiographic testing, eddy current testing, hardness testing).

Where particular parts of the tube are inspected using UT, the relevant requirements of ISO 6406:2005, 11.4 shall be met. Corrosion mapping or flaw detection may be used to further evaluate imperfection distribution.

NOTE Corrosion mapping is a pulse-echo ultrasonic technique that produces a colour graphic image of the area scanned. It involves scanning with one or more straight beam probes using a prescribed, dual axis scan pattern over the tube surface whilst taking thickness measurements. The measurements are converted into digital values, which are colour-coded to create a topographic map of the tube wall thickness profile. Images (C-scans) from individual scan areas can be assembled together to create a composite image covering large areas of the tube surface. The thickness profile of the corroded area can be evaluated at the time of the test and/or can be stored and used to monitor future surface degradation.

Eddy current testing (ET) may be used as part of the overall programme for tube examination and verification. The requirements for the examination, verification and equipment used for this technique are specified in EN ISO 15548 (all parts).

Magnetic Particle Testing (MT) may be used as part of the overall programme for the evaluation and detection of surface breaking and slightly sub-surface discontinuities within the tube. The general principles for this technique are given in EN ISO 9934-1.

5 NDE personnel qualification

Personnel supervising NDT work shall be certified to at least Level II in accordance with the requirements of EN ISO 9712.

A person at least qualified to the requirements of Level 1 of EN ISO 9712 shall set up the test and provide data to the Level 2 person.

6 Marking

After satisfactory completion of the periodic inspection and test programme the shoulder of the pressure vessel (tube), where accessible, shall be stamp-marked with the test date and the inspector's mark (see EN ISO 13769).

Under no circumstances shall the cylindrical section of the pressure vessel (tube) be hard-stamped.

Where the pressure vessel (tube) shoulder cannot be stamped, the nearest position to it where damage is unlikely to occur or the information unlikely to be rendered illegible shall be stamped. Where it is not possible to stamp the tube, other techniques shall be used to mark the information (e.g. installing a data plate or paint stencilling) or the information may be presented on another integral part of the installation, but as close as possible to the tube shoulder.

7 Certification/Report

A test certificate/report shall be signed by the competent person and issued to the operator and/or owner. The test certificate/report shall at least include:

a) the serial number(s) of the pressure vessel(s) (tube(s)) examined;

b) a description of the installation to include, where possible, photographic evidence (e.g. site details, pressure vessel (tube) installation and its/their position within the site);

c) the test date (day/month/year);

d) details of all tests performed and their outcomes;

e) a listing of all standards and parameters used during the course of the tests/examinations (e.g. pressures applied, equipment used);

f) the design standard of the pressure vessel (tube);

g) a listing of any deviations from the test/examination protocols used;

h) a listing of any deviations that have been identified but not deemed sufficient for the tube to fail the test; and

i) the date of next test (the elapsed period between tests may be shortened if any deviations are observed during the course of the test programme).

8 Rendering tubes unserviceable

The decision to reject a tube may be taken at any stage during the periodic inspection and test procedure.

If it is not possible to recover a rejected pressure vessel (tube), it shall (after notifying the owner) be made unserviceable for holding gas under pressure so that it is impossible for any part of the pressure vessel (tube), especially the shoulder, to be re-issued into service.

Once a pressure vessel (tube) has been rejected and after ensuring it is empty and free of gas, it shall be rendered unserviceable by, for example:

a) crushing (preferably in the shoulder area);

b) burning an irregular hole in the top dome equivalent in area to approximately 10 % of its area or, in the case of a thin-walled pressure vessel (tube), piercing it in at least three places;

c) cutting the neck in an irregular fashion;

d) cutting it, including the shoulder, into two or more irregular pieces;

e) bursting it in a safe manner.

The actual rendering of the pressure vessel (tube) to be made unserviceable shall be confirmed by the competent person either on site or at a later date, e.g. photographic evidence.

Annex A
(normative)

Description, evaluation of defects and conditions for rejection of refillable seamless steel pressure vessels (tubes) at the time of visual inspection

A.1 General

Defects can be physical, material or due to corrosion (e.g. as a result of environmental or service conditions to which the tube has been subjected during its life). This annex gives general guidelines regarding the application of rejection criteria.

Due to the nature of the examinations performed, it might not be always possible to see all the stamp markings (e.g. due to an abnormally thick coating of paint necessary for operating conditions). Such an omission is not a parameter for rejecting a tube.

Defects in the form of a sharp notch may be repaired using a controlled method (e.g. grinding or machining). After any repair using a metal removal technique, the tube wall thickness shall be checked (e.g. ultrasonically). The remaining wall thickness shall be at least equal to the minimum guaranteed wall thickness.

A.2 Physical or material defects

The types of defect included in this category are, but are not limited to:

a) dents;

b) cut or gouges;

c) cracks;

d) fire damage;

e) arc or torch burns; and

f) suspicious marks.

Evaluation of physical or material defects shall be in accordance with the requirements of EN 1968 (additional information can be found in ISO/TR 16115).

Attachments (e.g. foot-rings/supports) which could result in crevice corrosion shall be inspected to ensure they are suitable for their intended purpose.

A.3 Corrosion

A.3.1 General

Tubes can be subjected to environmental conditions that could cause external corrosion and in-service conditions that could result in internal corrosion. There is difficulty in presenting definite rejection limits in tabular form for all sizes and types of tube and their service conditions. Rejection limits are usually established as a result of considerable field experience.

Extensive experience and judgment are required in evaluating whether tubes that have corroded internally are safe and suitable for return to service. Where necessary, it is important that the tube internal surface is cleaned of corrosion products prior to inspection (e.g. mechanical flailing, shot blasting).

A.3.2 Corrosion types

Typical corrosion types are:

a) general;

b) local;

c) chain or line pitting; and

d) isolated pits or crevices.

A.3.3 Rejection criteria

Rejection criteria are shown in EN 1968:2002, Annex C (additional information can be found in ISO/TR 16115).

Annex B
(informative)

Procedure for the examination of refillable seamless steel pressure vessels (tubes) using acoustic emission (AE) techniques

B.1 General

This procedure relates to the AE examination of refillable seamless steel pressure vessel (tube) used for the storage of compressed gases and shall follow the requirements of EN ISO 16148.

The procedure involves pressurizing the vessel to a level greater than that experienced during the previous 12 months of service. The overpressure is normally at least 10 % above the tube working pressure and is intended to overcome the Kaiser effect.

This procedure is not to be used at tube temperatures below 5 °C. Below this temperature, the tube can become more brittle and there is less acoustic emission before failure.

The AE examination is used to detect and locate the longitudinal position of defects for subsequent examination using other NDT methods (e.g. shear wave ultrasonics to size (depth) defects and to determine their circumferential position).

B.2 Equipment

The equipment to be used is shown in Figure B.1.

B.3 Safety

All equipment used to conduct the tests shall be declared safe for use at the test site before any testing begins.

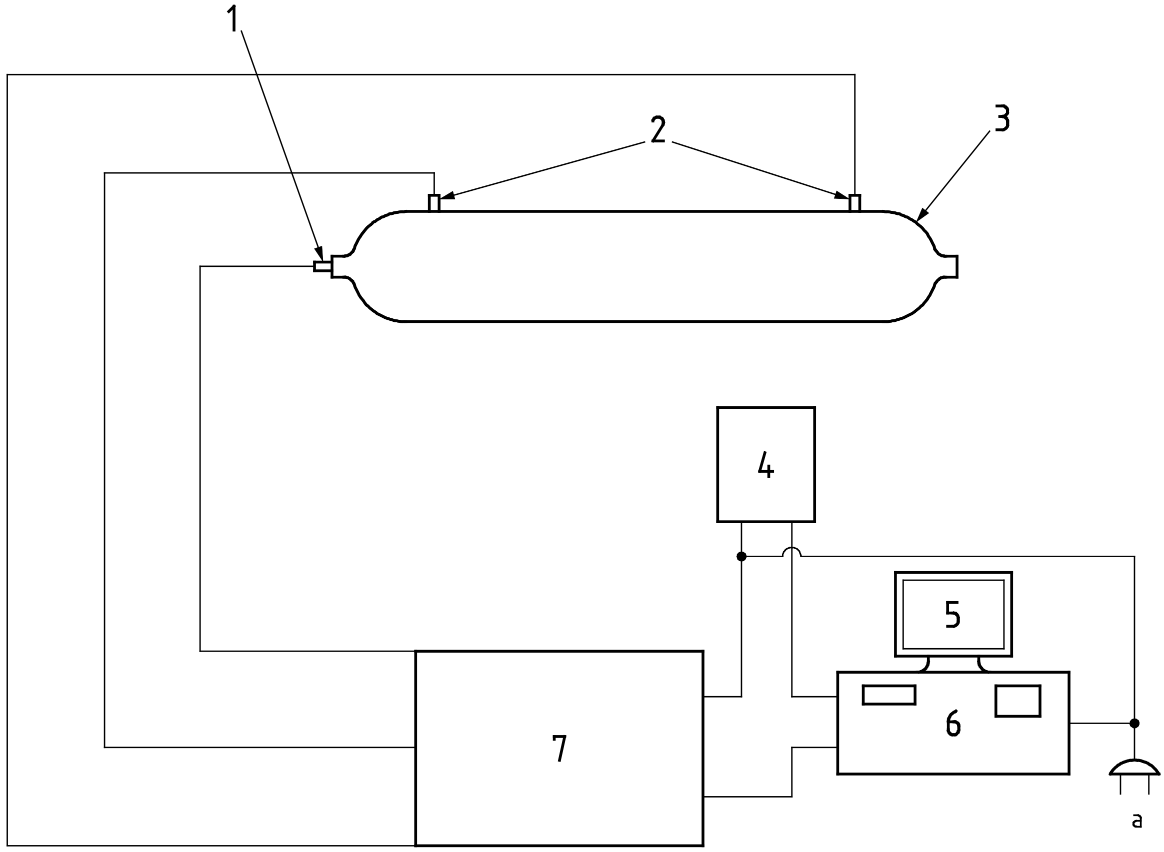
Some critical factors which might need to be considered are:

a) the suitability of the pressurization equipment to be used;

b) whether potentially explosive environments (e.g. hydrogen tubes) are present;

c) whether any circumstances which could result in tube failure (e.g. prior usage, history and consequences) are present;

d) the electrical safety (e.g. portable appliance testing (PAT)), stability of the electricity supply, the absolute voltage of the power supply and the suitability of the test equipment to be used for the tests to be carried out.



Key

1 pressure transducer

2 acoustic emission sensors with integral pre-amplifier (two for each pressure vessel (tube))

3 pressure vessel (tube) with sensors mounted on sidewall

4 printer

5 video monitor

6 computer

7 acoustic emission signal processor power

Figure B.1 — Example of an AE examination equipment diagram and sensor placing

B.4 Method

B.4.1 General

Tubes are generally tested in banks of up to 12 (24 channels/sensors). The traceability of each pressure vessel (tube)/sensor/channel should be retained.

B.4.2 Procedure

a) Ensure that where the sensors are to be attached, the surface of the pressure vessel (tube) is clean and free from grease and loose material. It might be necessary to prepare the tube surface before attaching the sensor or couplant to ensure a good acoustic contact (e.g. by removing excess paint or surface corrosion);

b) Attach two sensors to each pressure vessel (tube), one as near to each of the domed ends as possible (usually on the parallel section just before the dome radius begins). Attach sensors to each pressure vessel (tube) in similar locations (in order to obtain comparable readings) using a suitable acoustic couplant. There should be no air gaps between the sensor and pressure vessels (tube(s)) after installation;

c) Calibrate and check system performance by performing five pencil lead break tests (using a H-N 0.5 pencil with a 3 mm extension) per sensor. Each pencil lead break test should be performed 50 mm from the sensor along the parallel part of the pressure vessel (tube);

d) Each individual pencil break should produce, at the sensor, a minimum peak amplitude of 70 dB. Results should be recorded for each individual sensor and an average peak amplitude value (*PB*) calculated for each;

e) If the output from a sensor gives a peak amplitude that deviates by more than *PB* ± 4 dB, re-mount the sensor and repeat the pencil lead break test. If, after re-mounting the sensor, output remains outside limits, replace it with a new sensor and repeat B.4.2 a) and B.4.2 b);

f) Pressurize the pressure vessel (tube) to 50 % of the total test pressure to be applied and hold for 10 min. Perform a background acoustic noise check by monitoring the output from the sensors in order to evaluate whether there is any noise present from a combination of external sources (e.g. rain, wind, foliage brushing against the tube);

g) If background noise is present, the source should be established and eliminated, or its effect allowed for in the test results;

h) Continue to pressurize the pressure vessel (tube) using a fill rate slow enough to avoid excessive flow noise (e.g. 40 bar/h) until the maximum test pressure has been achieved;

i) Once the test sequence has been started, it may be held at the AE operator’s discretion at any point within the test cycle. Hold points are not mandatory;

j) Monitor and record (e.g. using a mass storage device) all sensor outputs during the test. If the data indicate that there are five or more anomalies in the tube within a linear distance of 200 mm, identify the area for further investigation by a different NDT method; and

k) When the maximum test pressure is reached, repeat step B.4.2 c) to confirm system functionality.

B.5 Real-time evaluation criteria

The real-time criteria that will result in a stop (e.g. for rejection of the pressure vessel (tube)) or pause (e.g. for further data analysis) in the pressurization sequence should be clearly defined before testing begins.

Supporting data for the choice of evaluation criteria should be made available from an appropriate source (e.g. database, standard or experience). Depending upon the location of the test site, rejection criteria can vary where specific local regulations apply.

Criteria that will result in rejection of the tested tube or in a stop of the pressurization sequence for further inspection are influenced by factors such as, but not limited to:

a) pressure vessel (tube) type;

b) pressure vessel (tube) material and heat treatment;

c) first or subsequent pressurization.

Pressure vessels (tubes) that have been rejected based on AE data should undergo a second inspection of the defective area(s) using an alternative test method (e.g. UE) before a decision is made about their being returned to service.

Real-time evaluation criteria may be based on events such as, but not limited to:

d) an increase in AE activity and/or energy as a function of pressure vessel (tube) pressure;

e) number N1 of located burst signals with a distance-corrected peak amplitude above a high specific value A1; and

f) number N2 of located burst signals with a distance-corrected peak amplitude above a low specific value A2 within an interval of size X % of the maximum distance between sensors.

NOTE The value of X depends on the AE equipment used, the number of sensors and the size of the tube (e.g. diameter size).

Tube pressurization should be stopped immediately if the AE energy increases in incremental steps from a defined value, for example:

g) the AE energy doubles in two consecutive pressure intervals of 5 % of the maximum test pressure; or

h) one of the specific predefined values for either N1 or N2 is exceeded.

B.6 Test report

Once all testing is completed, a test report from each AE examination should be prepared, containing at least:

a) the name(s) of tube owner(s);

b) the pressure vessel (tube) serial number(s) and manufacturer(s);

c) the test date and location;

d) any previous examination date(s) and test pressure(s);

   If the operator is aware of situations where the tube was subjected to pressure that exceeded normal filling pressure, these should be described in the report.

e) the normal filling pressure (supplied by the pressure vessel (tube) owner) and marked working pressure;

f) the pressurization medium;

g) the pressurization rate;

h) the pressure at which data acquisition commenced;

i) the AE test pressure;

j) the location of the AE sensors;

k) the location of any AE sources that exceed acceptance criteria, including distance from end of the tube that bears the serial number (usually this is stamped on the tube);

l) any acceptable variation from the AE test procedure;

m) the name, qualification and signature of the competent person;

n) a stacking chart that shows the relative locations of tubes and, if appropriate, the associated data channel number;

o) external visual examination results;

p) AE examination results including:

   1) events versus location plot for each pressure vessel (tube);

   2) distance-corrected amplitudes versus location plot for each pressure vessel (tube);

   3) cumulative events versus pressure (or time) for each channel of each tube; cumulative energy versus pressure plot for each channel of each tube or energy distribution histograms for each channel;

q) the examination procedure and revision number;

r) the type of AE instrumentation used;

s) a description of the pressure equipment;

t) a sketch with dimensions showing sensor and simulated source locations;

u) the results of system verifications including documentation on the achieved location accuracy.

Annex C
(informative)

Recommended time intervals for certain commonly contained gases

These recommendations are for those jurisdictions where no prescribed time intervals are specified in local/national regulations. Where there are regulations, they should take precedence over the time intervals quoted in Table C.1. This list of gases is not exhaustive.

Table C.1 — Time intervals

Gas	**Time interval (years) (1) (3) (4)**
Helium	10
Nitrogen	10 (2)
Oxygen (breathing)	10 (2)
Air (inhalation/industrial)	10 (2)
Carbon dioxide/ nitrous oxide	10 (2)
Hydrogen	10

Table C.1 quotes maximum intervals. Where the inspector and/or the owner/operator stipulate a lower time interval, then this shall be followed.

A shorter interval of five years shall apply if tubes are exposed to underwater or aggressive conditions.

NOTE At all times certain requirements may necessitate a shorter time interval, e.g. the dew point of the gas, cylinder design specification, change of gas service.

This test period may be used provided the dryness of the product and that of the filled cylinder are such that there is no free water and that this condition is proven and documented within a quality system of the filler. If these conditions cannot be fulfilled alternative or more frequent testing may be appropriate.

Annex D
(informative)

Pre–inspection site survey checklist / questionnaire

D.1 General

This annex consists of a series of typical areas which the inspector should assess during the pre-inspection site survey, to ensure a safe and thorough inspection be undertaken.

D.2 Regulation

The following listings should be checked prior to undertaking any testing:

a) a listing of any regulations that may apply / govern / broaden the scope of the inspection and test, i.e. legislation such as PSSR [10] [11], class recommended practices such as DNV-RP-E401 [14], etc.;

b) a listing of any specific customer requirements excluded from regulating documents (examples of which are given above), i.e. internal cleanliness / dryness, etc.

D.3 Product

D.3.1 Pressure Vessels (Tubes)

Aspects relating to the pressure envelope and fittings need to be recorded.

For all pressure vessels it is necessary to note the following:

— standard of manufacture, e.g. EN ISO 11120;

— any illegible or unauthorized stamp markings, unauthorized additions or modifications;

— any 'Special Considerations' i.e. special permits, re – rating, etc.;

— the nature of the gas contained and its compatibility with the pressure vessel (tubes);

— the relating pressure ratings i.e. working pressure and test pressure;

— aspects that could prevent adequate visual inspection i.e. surface cleanliness / condition, atmospheric attack from corrosion or verdigrises' / contamination, paint quality / adhesion, etc.;

— end threaded connection details i.e. 3 ¼' x 8 UN.

D.3.2 Fittings / Ancillary items

When handling fittings/ancillary items it is necessary to ensure that the inspector has:

— requirement to remove / retain items during testing i.e. valve assembly, pressure relief valve;

— relating items connection details, required for both inspection purposes (gauging) as well as coupling of test fittings.

D.3.3 Supports / Mountings

It is necessary that the inspector notes:

— type and location, i.e. end boxes, body brackets;

— if type / location of supports / mountings do present an issue to Inspection, i.e. obscuring external tube surface, etc. then would supplementary test technique/s, i.e. ultrasonic examination be necessary.

D.4 Installation

D.4.1 Suitable access

It shall be established that the correct conditions for the various types of testing can be met.

Suitable accessibility / sufficient room to remove fittings / ancillary items, connect test fittings, i.e. pressure transducer for AT.

D.4.2 Test technique

D.4.2.1 Conditions for acoustic emission testing:

— sufficient access to the required locations to connect sensors and conduct equipment verification check;

— ability to locate test equipment within any required parameters i.e. power / signal cable length shall not exceed 150 m;

— additional relating pressures i.e. normal filling pressure;

— when Method B as per EN ISO 16148 is used, see D.4.2.2;

— ability to control pressurization rates;

— ability for pressurization to be paused or the pressure reduced instantaneously;

— ability to eliminate or sufficiently control ‘background noise’, i.e. mechanical contact, electromagnetic interference, airborne particles (sand, raindrops), etc.

D.4.2.2 Conditions for hydraulic pressure testing:

— ability to completely fill the pressure vessel in order to conduct the test;

— ability of the supports / mountings to withstand increase in filled weight;

— ability to ensure that all hydraulic fluid can be eliminated post testing.

D.5 Risk analysis

A risk analysis should be undertaken to establish:

— suitability of the tubes and related fittings / ancillary items to withstand the relevant test pressure and weight;

— ability to apply necessary safety precautions to protect personnel carrying out the testing due to considerable damage potential from the relating stored energy that can be released (gas or hydraulic fluid);

— location-based risk-assessment, i.e. working at height, confined space considerations (volume of gas /asphyxiation hazard), etc.

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