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Item 5(a) of the provisional agenda

**Proposals for amendments to RID/ADR/ADN:
pending issues**

Alternative methods for periodic inspection of refillable pressure receptacles

**Transmitted by the European Liquefied Petroleum Gas Association
(AEGPL) on behalf of the informal working group on alternative
methods for periodic inspections**

General

As agreed at the Autumn 2016 session of the Joint Meeting, this Informal document is the report of the work of the Working Group on Alternative Methods for Periodic Inspections of refillable pressure receptacles, that met in Paris on January 10th and 11th 2017.

This document proposes:

- A General Provision composed of Proposals 1 and 2
- A Specific Provision in Proposal 3

The answers to the points raised during last Geneva Autumn Joint meeting (see ECE-TRANS-WP15-AC1-2016-GE-Inf37r1e), are provided as follows:

- Clarify uncertainties on the scope of the statistical tests:
 - Make clear for which types of cylinders it can be applied
 - Make clear which ADR 6.2.1.6.1 checks (a to e) are concerned
 - See paragraph 6.2.3.5.3 of proposal 1
- Be more precise and consistent in using statistical terms applied to pressure receptacles
 - See paragraphs 6.2.3.5.3.2.3 a), b) and c) of proposal 2 and different notes in proposals
- Be clearer on the responsibilities for manufacturers (eg availability of cylinder's data), owners, filling centers, retest facilities & inspection bodies
 - See paragraphs 6.2.3.5.3.2.3 c), d), i) and j) of proposal 2
- Provide more detailed requirements with regards to activities of sampling, destructive tests and statistical analysis
 - See paragraphs 6.2.3.5.3.2.3 e), f) and g) of proposal 2

- Improve the determination of population groups for statistical purposes (sampling)
 - See paragraphs 6.2.3.5.3.2.3 b) and c) of proposal 2
- Define minimum sampling size. (linked to the confidence level)
 - See paragraph 6.2.3.5.3.2.3 e) of proposal 2 for requirements about definition of a minimum sampling size, in liaison with 6.2.3.5.3.2.1
- Statistical methods shall enable to monitor degradation (ageing) of mechanical properties. (note : no requirements in the ADR concerning in service ageing tests / residual life time beside Note 2 in 6.2.2.1.1 and 6.2.2.1.2)
 - See paragraph 6.2.3.5.3.2.3 h) of proposal 2
- Analyse methods for Periodic Inspection with respect to their capability to measure degradation (ageing) concerning determination of life time.
 - See paragraph 6.2.3.5.3.2.3 h) of proposal 2
- Consider Interactions with standardization (CEN – ISO)
 - See paragraph 6.2.3.5.3 of proposal 1

With regard to Over-Moulded Cylinders, during the working group session, the OMC specific case has been used to illustrate the requirements for an alternative method.

Elements related to current failure rate in service and NDT for OMC controls have been discussed.

- See Proposal 3 for OMC specific Provision

Proposal 1 - General provisions

(to be added as a new sub-section 6.2.3.5.3 to read as follows:)

“6.2.3.5.3 General provisions for the substitution of dedicated check(s) for periodic inspection required in 6.2.3.5.1

This subsection applies to types of pressure receptacles designed and manufactured in accordance with standards referred to in 6.2.4.1 or a technical code in accordance with 6.2.5, and for which the inherent properties of the design prevent one or more of the checks for periodic inspections required in 6.2.1.6.1 (b) to (e) either to be successfully applied or to provide meaningful results.

Note 1: A result deems to be meaningful if it allows safety to be assessed and a potential safety degradation to be detected.

For such pressure receptacles, these inadequate check(s) shall be replaced by alternative method(s). The alternative method(s) and the related types of design shall be specified in the relevant paragraph of 6.2.3 and detailed in a special provision or in a referenced standard.

Note 2: The use of the alternative method(s) is limited to the specified type(s) of design only.

The alternative method(s) shall state which check(s) for periodic inspection according to 6.2.1.6.1 (b) to (e) is/are substituted.

The alternative method(s) in combination with the remaining checks according to 6.2.1.6.1 (b) to (e) shall ensure at least a level of safety equivalent to the level of safety reached by pressure receptacles of similar size and use which are periodically inspected in full compliance with 6.2.3.5.1.

6.2.3.5.3.1 Non-destructive testing as an alternative method

The inadequate check(s) identified in 6.2.3.5.3 shall be substituted by a non-destructive test method to be performed on each individual pressure receptacle.

6.2.3.5.3.2 Destructive testing as an alternative method

If no non-destructive test method leads to an adequate level of safety, the inadequate check(s) identified in 6.2.3.5.3 shall be substituted by a destructive test method in combination with its statistical evaluation.

Proposal 2 - General provisions for destructive tests and evaluation of the results

(to be added as new paragraphs 6.2.3.5.3.2.1, 6.2.3.5.3.2.2 and 6.2.3.5.3.2.3 to read as follows:)

“6.2.3.5.3.2.1 Safety level assessment of the alternative method

The safety level resulting from the alternative destructive method(s) in combination with the remaining checks according to 6.2.1.6.1 (b) to (e) shall be evaluated. It shall be adequate to the currently provided reliability level (e.g. 1 of 1 million) on the basis of a one-sided confidence level of 95%, according to standard EN xxxxxxxx.

For determination of the reliability level, the potential consequences of an in-service failure of the pressure receptacle design type shall be considered.

6.2.3.5.3.2.2 General provisions for destructive tests and evaluation of the results

The detailed method for destructive testing, and the evaluation of test results, shall be described in a special provision or in a referenced standard and shall provide all the following elements:

- List of checks required in 6.2.1.6.1 (b) to (e) to be replaced by destructive tests of samples;
- Description of the relevant population of pressure receptacles;
- Procedure for random sampling of individuals to be tested;
- Procedure for destructive test(s) to be applied;
- Procedure for statistical evaluation of test results;
- Specification of acceptance criteria;
- Determination of the periodicity of destructive sample tests;
- Measures to be taken if acceptance criteria are met but a safety relevant degradation of material properties is observed;
- Measures to be taken if acceptance criteria are not met.

6.2.3.5.3.2.3 The procedure shall provide the following information:

(a) Type of design

Definition of the types of design to which the alternative method applies.

(b) Basic Population

Description of how to define a basic population according to the production of a dedicated design type variant during a dedicated time span by a dedicated manufacturer.

A new basic population shall be defined in case of any modification to the design, the material, the production process or any other changes affecting the mechanical properties of the pressure receptacles in production, even though within the same type approval.

(c) Population groups

Description of the criteria for defining population groups.

Each basic population, considered for statistical assessment, shall be separated into clearly defined groups of pressure receptacles owned/operated by one dedicated company; in the following named "population group". A population group can be limited to a smaller number of pressure receptacles, as technically appropriate according to e.g. use, traceability and recall measures.

Deviating from this, within the relevant basic populations the groups can be organized by more than one owner/operator under the following conditions:

- The different owners/operators use the group in the same mode of operation
- Duties and responsibilities are regulated in a contract that also includes each involved filling centre;
- The filling centres work under the supervision of at least one of the owners or operators; and
- In the event of a change in ownership, the concerned population groups are transferred to the new owner with its design, manufacture, inspection and operational documentation and its full database.

(d) Traceability

Measures shall be taken to ensure traceability of each pressure receptacle to its population group. The owner shall collect all relevant data on filling, inspection/retesting and maintenance, correlation with its population group and selection for sampling in a database. The owner shall update data at least on a monthly basis.

Filling centres and inspection bodies shall have access to the data from the owner in order to check individual pressure receptacles. Before filling or periodic inspection of a pressure receptacle, the database system shall automatically cross-check the data of the relevant population group concerning next measures to take.

Pressure receptacles for which traceability cannot be ensured shall not be offered for service.

The complete set of data shall be made available to the competent authority upon request.

(e) Sampling for statistical assessment

The procedure for random sampling shall ensure reproducibility of both representative sampling and interpretation of statistical assessment of a population group.

The minimum number of individual pressure receptacles in a sample taken out of a population group and the periodicity of sampling shall be determined.

(f) Test procedure for a destructive alternative method

The procedure(s) for destructive testing must be clearly detailed to ensure reproducibility of test parameters and conditions. Each collected sample shall be tested, relevant test results shall be documented individually and provided for statistical assessment of the relevant population group.

Tests results shall be available for the entire life of the relevant population group.

(g) Statistical evaluation of test results

The procedure for statistical evaluation of sample test results shall be described. It shall provide data on the requested reliability level, and the statistical values of the acceptance criteria for the relevant test. All test results of destructive tests specified in (f) and in no case less than the minimum amount of pressure receptacles, determined in (e) for sampling, shall be evaluated for the relevant population group.

This analysis shall assess the distribution function and take into account its potential modifications caused by degradation during service.

Note: Distribution function: Test results are randomly distributed around a mean value. For an appropriate safety assessment, this distribution is described by a function (distribution function) and the relevant parameters of this function (e. g. mean value and scatter value).

(h) Measures in case of detected degradation

If the statistical assessment of test results meets the acceptance criteria but a safety relevant degradation of the properties of the pressure receptacle is detected, a procedure for determining the residual life of the affected population groups has to be added.

The modification of periodicity of tests might be necessary.

(i) Measures if requirements are not met

If the statistical assessment of test results representing a population group does not meet the acceptance criteria, the affected population group shall not be made available for filling or use and shall be taken out of service.

The reasons for not meeting the acceptance criteria shall be analysed. It shall be assessed whether other population groups are affected and if so they have to be taken out of service.

If an Xa body, in accordance with 6.2.3.6.1, can demonstrate that defined parts of the population group are not affected, the competent authority or its delegate may permit further use of unaffected parts of the population group.

(j) Filling center

Filling centers, filling pressure receptacles according to 6.2.3.5.3 shall operate under a documented quality system according to the ISO 9000 (series) or equivalent to ensure that following points are fulfilled and correctly applied:

- all the provisions of paragraph (7) of packing instruction P200;

- all the requirements of the alternative method and responsibilities for its application;

The quality system shall be certified by an accredited independent body recognized by the competent authority.”

Proposal 3 – Alternative Method of Periodic Inspection dedicated to Over-Moulded Cylinders

1. Add the following definition in 1.2.1:

“*Over-moulded cylinder* means a cylinder intended for the carriage of LPG of a water capacity not exceeding 13 litres made of a coated steel inner cylinder with an over-moulded protective case made from cellular plastic, which is non removable and bonded to the outer surface of the steel cylinder wall”.

2. Insert “6XY” in column (6) of the Dangerous Goods list for the entries for UN numbers 1011, 1075, 1965, 1969 and 1978.

3. Add the following specification about periodic inspection for over-moulded cylinders in a new sub-section 6.2.3.5.4 to read as follows:

“6.2.3.5.4 Over-moulded cylinders shall be subject to periodic inspection and tests in accordance with special provision 6XY of Chapter 3.3”.

4. Insert the following special provision in 3.3.1:

“6XY This entry applies to periodic inspection of over-moulded cylinders as defined in 1.2.1.

Over-moulded cylinders shall be subject to periodic inspection in accordance with 6.2.1.6.1, adapted by the following alternative method:

- Substitute check 6.2.1.6.1 d) by alternative destructive tests.
- Perform specific additional destructive tests related to the design of over-moulded cylinders.

Procedure and requirements of this alternative method are described below.

Alternative Method:

(a) General

The following provisions apply to over-moulded cylinders produced serially and based on steel cylinders in accordance with prEN1442:2014, EN14140:2015 or annex I, parts 1 to 3 to Council Directive 84/527/EEC. The design of the over-moulding shall prevent water from penetrating into the inner steel cylinder. The conversion of the base steel cylinder to an over-moulded cylinder shall comply with the relevant requirements of prEN1442:2014 and EN14140:2015.

Over-moulded cylinders shall be equipped with self-closing valves.

(b) Basic Population

A basic population of over-moulded cylinders is defined as the production of cylinders from only one over-moulding manufacturer using inner cylinders manufactured by only one manufacturer within one calendar year, based on the same design type, the same materials and production processes, owned/operated by one company.

(c) Population Group

Within the above defined basic population, over-moulded cylinders can be separated into population groups dedicated to one owner, if over-moulded cylinders from the same basic population have been purchased by different entities.

(d) Traceability

Inner steel cylinder markings in accordance with 6.2.3.9 shall be repeated on the over-moulding. In addition, each over-moulded cylinder shall be fitted with an individual resilient electronic identification device. The detailed characteristics of the over-moulded cylinders are recorded in an information technology database. The database shall be used to:

- Make the specific technical characteristics of the cylinders (eg. steel cylinder production batch, over-moulding production batch, day of over-moulding, etc ...) available to competent authorities, inspection bodies or filling centers;
- Identify the cylinder by linking the serial number and the electronic device to the database;
- Check past and upcoming measures (filling, retesting, withdrawal, sampling and others);
- Record the date and place of performed measures.

Data shall be recorded and kept available by the owner of the over-moulded cylinders for the entire life of the population group.

(e) Sampling for statistical assessment

Sampling shall be random among a population group as defined in (c). The size of each sample per population group shall be in accordance with the table of paragraph (g).

(f) Test procedure for destructive testing

The tests of 6.2.1.6.1 shall be supplemented by the following procedures:

- Adhesion tests (according to EN 1442 or EN14140)
- Peeling and Corrosion tests (according to EN ISO 4628-3)

The test in 6.2.1.6.1 d) shall be substituted by the following procedures:

- Burst tests (according to EN 1442 or EN 14140)

Adhesion tests, Peeling tests and Burst tests shall be performed on each related sample according to the table of paragraph (g) and shall be conducted after 3 years in service and every 5 years thereafter.

(g) Statistical evaluation of test results –Method

The procedure for statistical evaluation is described in the following steps.

Step 1: Determination of character of distribution

For each population group, a first sampling of 20 pieces shall be made and each piece shall be subject to burst tests.

Results for burst pressure shall be checked according to the Joint Test (multidirectional test) using a significance level of $\alpha=0.05$ (see paragraph 7

of ISO 5479:1997) to determine whether the distribution of results for each sample is normal or non-normal.

For normal distribution, the next phase of the procedure is given in step 2.1

For non-normal distribution, the next phase of the procedure is given in step 2.2

Step 2.1: Complementary procedure for results following a normal distribution

For each population group following a normal distribution, sampling, tests and evaluation shall be done according to the table 1 below, and its related comments.

Table 1

Test interval (years)	Test type	Standard	Rejection criteria	Population Group sampling level	Test results
After 3 years in service	Burst test	EN 1442	Burst pressure (*) < 70 bar in propane service or 50 bar in butane service	$3\sqrt[3]{Q}$ or $Q/200$ whichever is lower, (including the 20 first samples)	If any test fails, repeat tests replacing Q with monthly production q of representative sub-population groups
	Peeling and corrosion	EN ISO 462 8-3:2004	Max corrosion grade: Ri2	Q/1 000	
	Adhesion of Polyurethane	ISO 2859-1 EN 1442 EN 14140:2014	Adhesion value > 0.5 N/mm ²	See ISO 2859-1 applied to Q/1000	
Every 5 years thereafter	Burst test	EN 1442	Burst pressure (*) < 70 bar in propane service or 50 bar in butane service	$6\sqrt[3]{Q}$ or $Q/100$ whichever is lower, and with a minimum of 40 per population group (Q) (including the 20 first samples)	
	Peeling and corrosion	EN ISO 462 8-3:2004	Max corrosion grade: Ri2	Q/1 000	

	Adhesion of Polyurethane	ISO 2859-1	Adhesion value > 0.5 N/mm ²	See ISO 2859-1 applied to Q/1000
Q	Represents the population group.			
q	Represents a continuous over-moulded cylinder sub-population group.			

(*) For the groups of figures of burst pressure, the “right” unilateral statistical tolerance interval shall be calculated for a confidence level of 95% and a fraction of population equal to 99%. The calculation is made in accordance with the standard ISO 16269-6:2005 admitting, for each related population groups, the normality of the population and considering that the variance is unknown.

The tolerance interval with coverage p at confidence level $1 - \alpha$ has lower limit x_L defined by this formula:

$$x_L = \bar{x} - k_3(n;p;1-\alpha) \times s$$

with

\bar{x} : sample mean;

s : sample standard deviation;

k_3 : tabulated factor function of n , p and $1-\alpha$;

NOTE: This value can be read from the Table D.4 given in Annex D of ISO 16269-6:2005.

p : proportion of the population selected for the tolerance interval (99%);

$1 - \alpha$: confidence level (95%);

n : sample size.

Step 2.2 : Complementary procedure for results following a non-normal distribution

For each population group following a non-normal distribution, sampling, tests and evaluation shall be done according to the table 2 below, and its related comments.

Table 2

Test interval (years)	Test type	Standard	Rejection criteria	Population group sampling level	Test results
After 3 years in service	Burst test	EN 1442	Burst pressure (*) < 70 bar in propane service or 50 bar in butane service	299 samples (*) (see Annex F of ISO 16269-6:2005) (including the 20 first samples)	If any test fails, repeat tests replacing Q with monthly production q of representative sub-population group
	Peeling and corrosion	EN ISO 462 8-3:2004	Max corrosion grade: Ri2	Q/1 000	
	Adhesion of Polyurethane	ISO 2859-1 EN 1442 EN 14140:2014	Adhesion value > 0.5 N/mm ²	See ISO 2859-1 applied to Q/1000	
Every 5 years thereafter	Burst test	EN 1442	Burst pressure (*) < 70 bar in propane service or 50 bar in butane service	299 samples (*) (see Annex F of ISO 16269-6:2005) (including the 20 first samples)	
	Peeling and corrosion	EN ISO 462 8-3:2004	Max corrosion grade: Ri2	Q/1 000	
	Adhesion of Polyurethane	ISO 2859-1	Adhesion value > 0.5 N/mm ²	See ISO 2859-1 applied to Q/1000	
<p>Q Represents the population group.</p> <p>q Represents a continuous over-moulded cylinder sub-population group.</p>					

(*) For the groups of figures of burst pressure, the “right” unilateral statistical tolerance interval shall be calculated for a confidence level of 95% and a fraction of population equal to 99%. The calculation is made in accordance with the standard ISO 16269-6:2005.

The tolerance interval with coverage p at confidence level $1 - \alpha$ has lower limit xL defined by this formula:

$$xL = x_{\min}$$

with

x_{\min} : extreme minimum value of measurements from the samples

(h) Measures if requirements are not met

If a result of the burst test, peeling test or adhesion test does not comply with the criteria detailed in the previous table, potentially affected production batches of over-moulded cylinders shall not be made available for transport and use. In agreement with the competent authority, its delegates or the Xa-body which issued the design approval, additional tests might be performed to determine the root cause of the failure and the affected period of the steel cylinder production or of the production of the over-moulding. Over-moulded cylinders not produced in the affected period may be authorized by the competent authority to be put back into service.

(i) Filling center requirements

The owner shall demonstrate to the satisfaction of the competent authority that the over-moulded cylinders are only filled in filling centers that apply a documented quality system to ensure that all the provisions of paragraph (7) of packaging instruction P200 are met and that the requirements of EN1439:2008 are correctly applied. Each filling center shall have:

- The appropriate means to identify over-moulded cylinders through the electronic identification device;
- Availability of the relevant information;
- The capacity to update the relevant information.

The owner shall provide documentary evidence to the competent authority that the filling center complies with these requirements and that the quality system, according to the ISO 9000 (series) or equivalent, is certified by an accredited independent body recognized by the competent authority.

5. Remove the exclusion of sub-section 3.5 and of annex G for EN 1439:2008 in the table in point 11 in P200.

6. Remove the exclusion about "Over-moulded cylinders" for EN 14140:2014+AC:2015 in the table in sub-section 6.2.4.1