

Economic Commission for Europe

Inland Transport Committee

Working Party on the Transport of Dangerous Goods

**Joint Meeting of the RID Committee of Experts and the
Working Party on the Transport of Dangerous Goods**

19 September 2017

Geneva, 19–29 September 2017

Item 5 (a) of the provisional agenda

Proposals for amendments to RID/ADR/ADN:

pending issues

Periodic inspection and test of some transportable refillable LPG steel cylinders

**Transmitted by the European Liquefied Petroleum Gas Association
(AEGPL) on behalf of the Working Group on Alternative Methods for
Periodic Inspections**

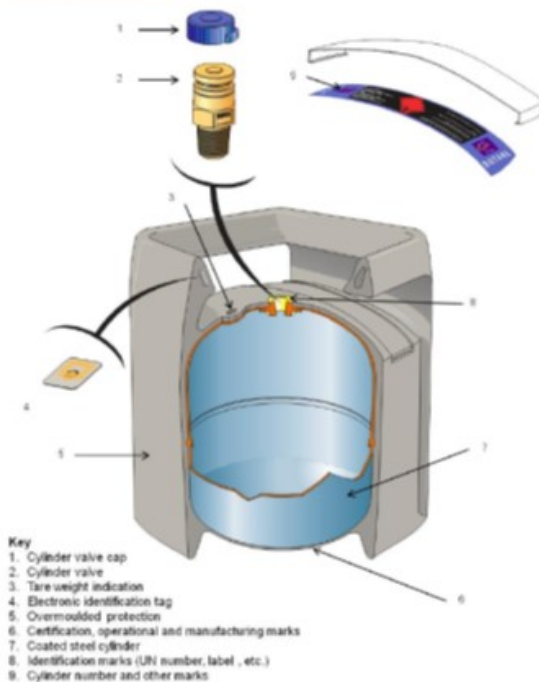
General

Following the last session of the Working Group on Alternative Methods for Periodic Inspections, and parallel to the Working Paper ECE/TRANS/WP.15/AC.1/2017/33, the Working Group has agreed to propose to the Joint Meeting, at the next September Session in Geneva, the following presentation.

This presentation gives explanations and illustrates:

- The global process and format that has to be respected in case of a request for an alternative method to be introduced in the RID/ADR (according to the General Provision given in Proposal 1 of the aforesaid Working Paper)
- An application to a real case called Over-Moulded Cylinders.

Over-Moulded Cylinders – *Need for alternatives*



Example of protected over-moulded cylinder

Over-moulded cylinder :

- A coated steel inner cylinder with a bonded and non removable over-moulded protective case made of polyurethane

Periodic Inspections :

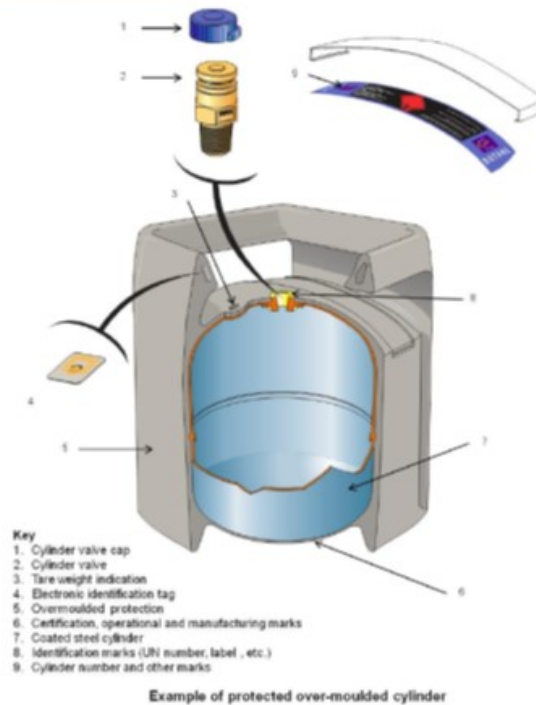
- Due to inherent properties of the design, small defects can be hidden by the cover during Hydraulic Pressure test :
 - Check 6.2.1.6.1 d) is not relevant



An alternative method had to be defined

Restricted

Over-Moulded Cylinders – *Need for alternatives*



Demonstration of non-relevance of other Non-Destructive methods for substitution :

- Ultrasonic technology
 - Attempts with various sensors and frequencies
 - Conclusions : PU absorbs waves before reaching steel
- Acoustic Emissions
 - No possible contacts with steel → sensors cannot be applied
 - PU thickness attenuates waves
- X-rays
 - Does not detect holes lower than 200µm, which is above our usual criterias
 - Does not detect surface or spot corrosion

➔ Destructive Tests had to be considered



Restricted

Over-Moulded Cylinders – Alternative Method

An alternative method has been defined to substitute Check d), based on :

- Burst Tests, combined with statistical evaluation
- Additional Peeling and Corrosion Tests and Adhesion Tests

Burst Tests

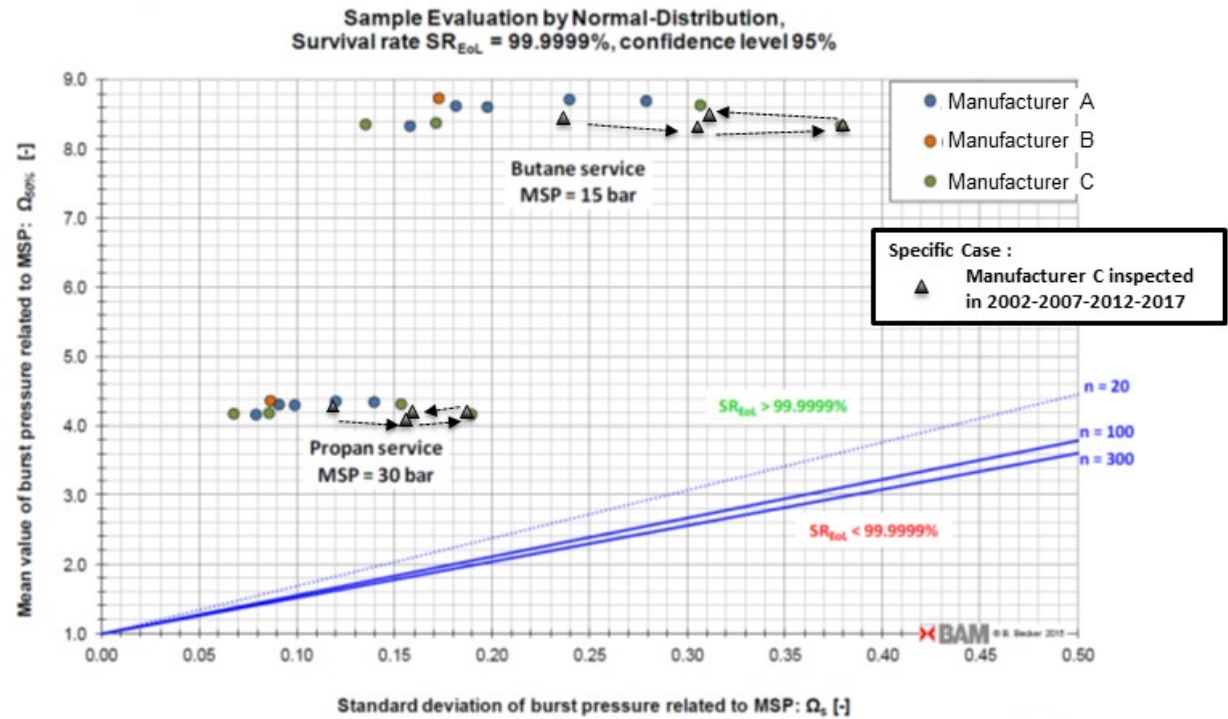


- Test procedures, Acceptance Criteria have been defined from related Standards, Expertises or Regulation, and agreed by French Authorities (step by step process in 2000, 2001 and 2002)
- Statistical evaluation of tests results has been based on the probabilistic approach*, which is visualized in the Sample Performance Chart (SPC) developed by BAM.

Statistical procedures of this method have been developed under BAM supervision to ensure conformity and a Survival Rate of 99,9999%.

* Mair, Georg W.: Safety Assessment of Composite Cylinders for Gas Storage by Statistical Methods. London: Springer Ltd. 2017.

Over-Moulded Cylinders – Real application in SPC

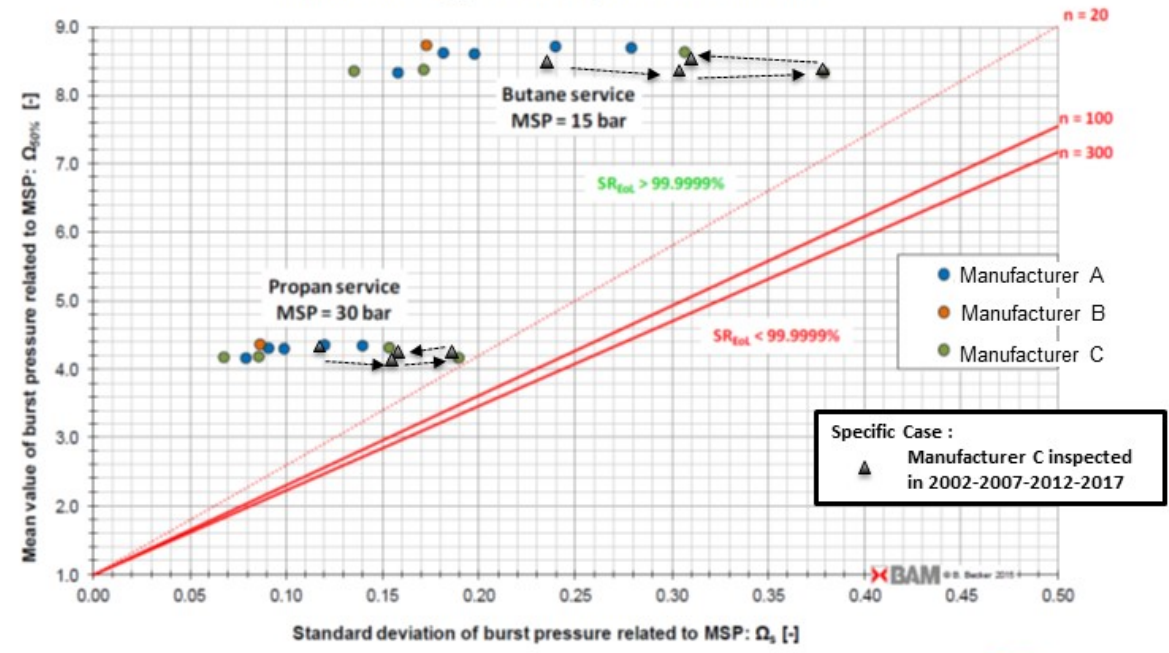


Restricted



Over-Moulded Cylinders - Real application in SPC

Sample Evaluation by Weibull-Distribution,
Survival rate $SR_{EoL} = 99.9999\%$, confidence level 95%



Restricted



Over-Moulded Cylinders – Additional Tests

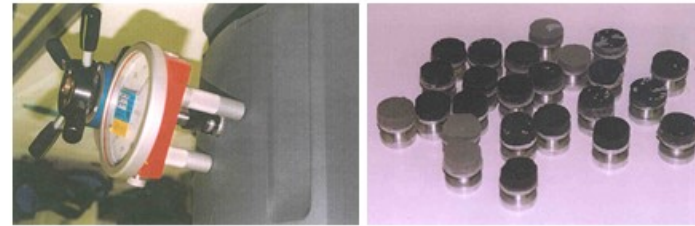
Complementary to the bursts Tests, these tests enable :

- Measurements of the performances at different ages
- Follow up of Quality and Ageing behaviour all along the life of the cylinders

Peeling and Corrosion Tests

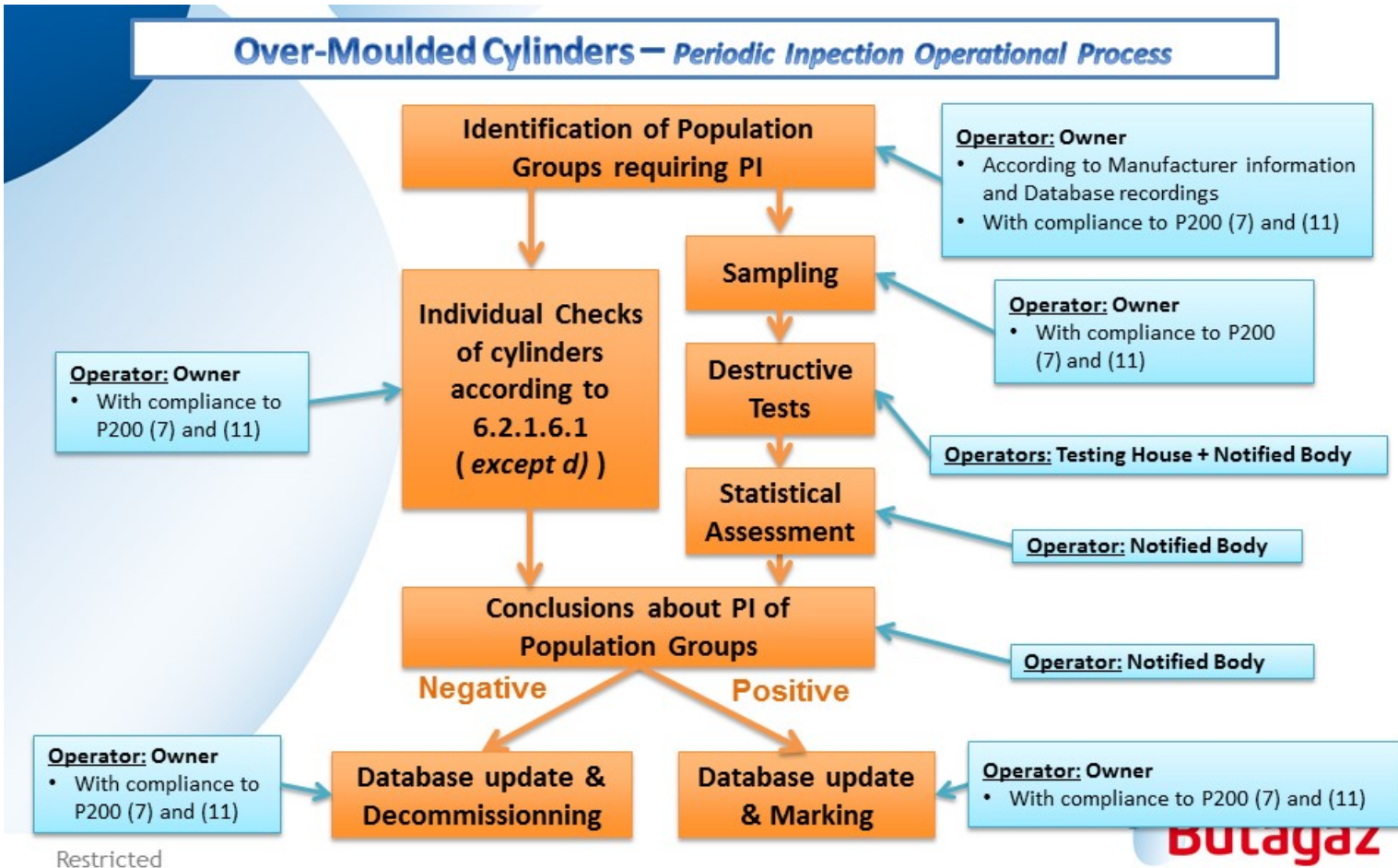


Adhesion Tests



Restricted

 **Butagaz**



Over-Moulded Cylinders – Feedback after 20 years

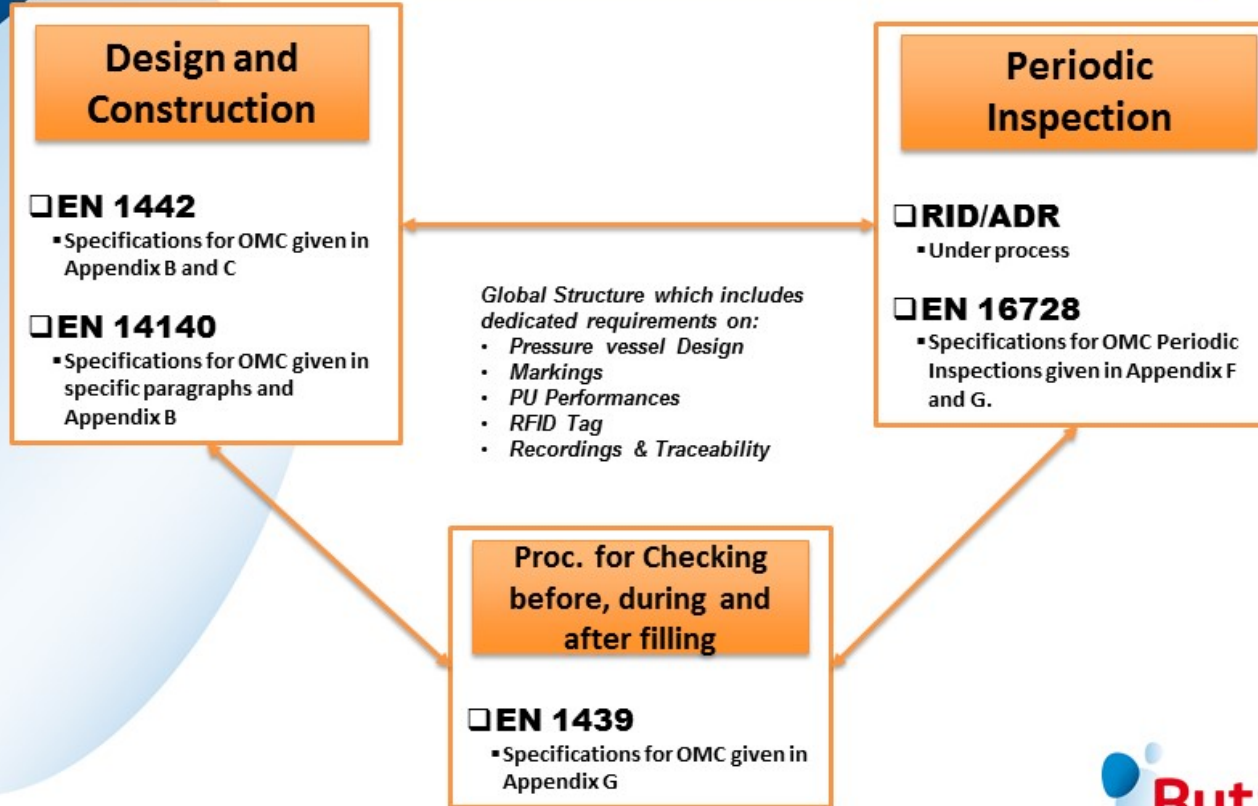
Total amount of Cylinders tested between 2000 & 2016 (manufactured between 1997 & 2013)	Number of Tests		
	Burst	Peel Off	Adhesion
	18184	9013	680
	27877		

Feedback from filling and testing centers	For Over-moulded Cylinders		
	Year	Total number of Leakages	Details
	2000/2016	17	<ul style="list-style-type: none"> Leakages on the valve : 16 Leakage on the cylinder : 1 <ul style="list-style-type: none"> Welding of the boss (in 2005)
	No rust detected		

Restricted



Over-Moulded Cylinders - Standard structure



Restricted

