OTIF

ORGANISATION INTERGOUVERNEMENTALE POUR LES TRANSPORTS INTERNATIONAUX FERROVIAIRES

ZWISCHENSTAATLICHE ORGANISATION FÜR DEN INTERNATIONALEN EISENBAHNVERKEHR

INTERGOVERNMENTAL ORGANISATION FOR INTERNATIONAL CARRIAGE BY RAIL

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Original: German

RID: **Exchange of experiences for recognized experts in accordance with paragraph 6.8.2.4.6 of RID**
(Berne, 13 May 2008)

Subject: **Verification of resistance to external over pressure in connection with standard EN 13445**

Proposed topic for discussion transmitted by Germany

The problem

The design in accordance with standard EN 14025 in conjunction with measuring the out-of-roundness in accordance with standard EN 13445 is difficult to implement in practice.

How hard and fast is the method of measuring? Which alternative methods may be used?

The situation with regard to the provisions

EN 14025:2008

Section 6.4 stipulates how to calculate resistance to external pressure.

6.4.1 General

Resistance to external pressure must be calculated in accordance with section 8 of EN 13455-3:2002.

6.4.2 Tanks, where external pressure is part of operating conditions

Safety factor **k = 1.5**

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6.4.3 Tanks, where external pressure is **not** part of operating conditions

See A.2.8 (text of RID/ADR 6.8.2.1.7: 21 or 40 kPa)
Safety factor **k = 1.1**
When calculating using FEM
– Safety factor **k = 1.5**
– Apply out-of-roundness u of at least 1% of the inner diameter.
– The maximum out-of-roundness u shall be 1.5%.

6.4.4 Test

Resistance to external pressure may also be verified by a test on a prototype tank with a negative internal design pressure increased by the safety factor k = 1.25.

Section 7.5 specifies the manufacturing tolerances

7.5.5 Cylindrical sections

7.5.5.1 The actual circumference shall not deviate from the circumference calculated from the specified diameter by more than ± 1.5 %.

7.5.5.2 The out-of-roundness u shall not be greater than ± 1.5 % when calculated from the expression:

$u = [200 * (D_{max} – D_{min})] / (D_{max} + D_{min})$
where
D_{max} is the maximum diameter of the cylindrical section, in mm
D_{min} is the minimum diameter of the cylindrical section, in mm

7.5.5.3 Departure of the cylindrical section of the shell from a straight line shall be not greater than 0.5% of its length, except where required by the design.

EN 13455-3:2002

8 Shells under external pressure
8.5 Cylindrical shells
8.5.1 Circularity limits
8.5.1.1 Test for circularity tolerance

Requirements in
– 8.5.2 Non-reinforced cylindrical shells
– 8.5.3 Reinforced cylindrical shells
apply to cylinders which are circular to within **0.5% on radius** (0.005R) measured from the true centre.

Measuring procedures:
– Appendix D (Informative) Verification of the shape of vessels
– Appendix E (Normative) Procedure for calculating the departure from the true circle of cylinders and cones

Appendix D (informative)

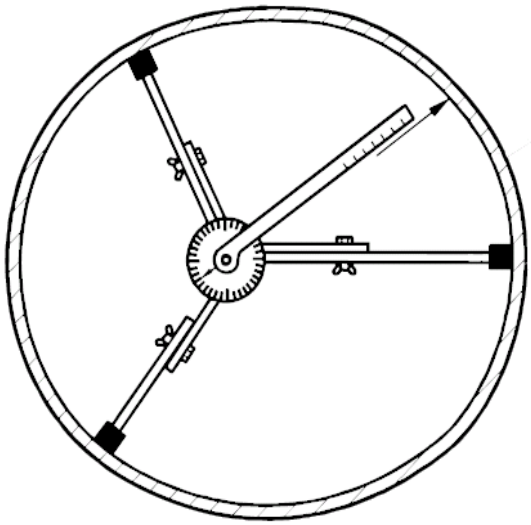

Diagram D-1 – Swing arm

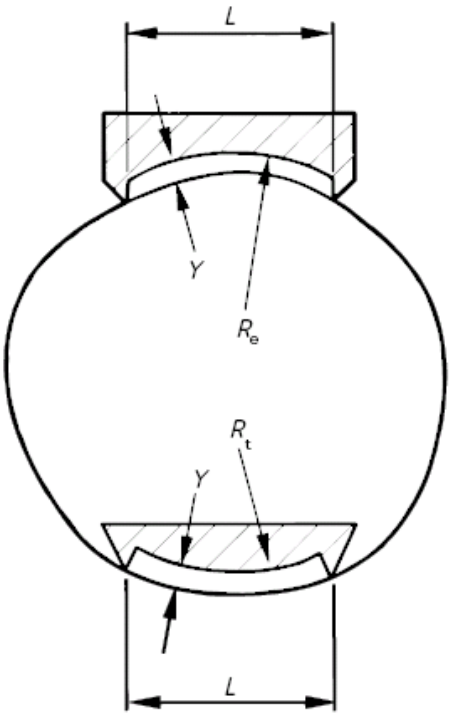

Diagram D-2 – Internal and external calliper

Appendix E (normative)

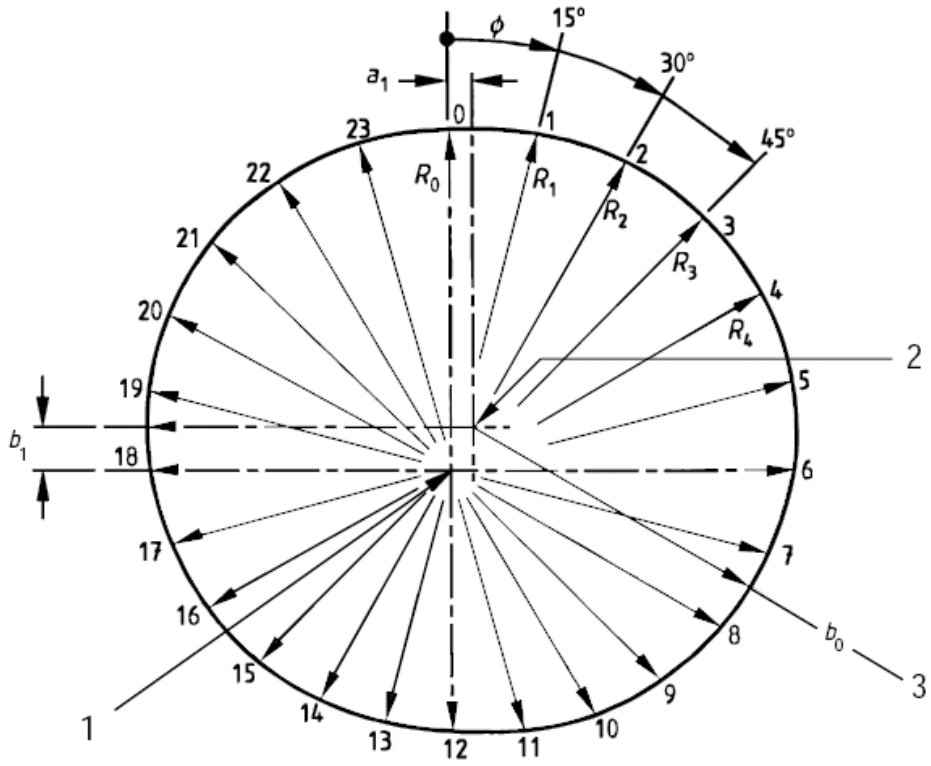

Diagram E-1 – Radius measurements and the true centre

8.5.1.2 Circularity tolerance for cylinders with excess thickness

Where the allowable pressure Pr/S determined in 8.5.2.2 is greater than the design pressure, then the required tolerance for the cylinder may be increased to

Tolerance = 0.005 * Pr / P*S

8.5.1.3 Allowable pressure when circularity exceeds 0.5 % tolerance

Annex F gives a procedure by which the allowable pressure may be calculated for cylinders which are found after manufacture to exceed the 0.5 % circularity tolerance.

Comment on measurements in accordance with EN 13445-3:

The measurements in accordance with EN 13445-3 are described clearly but are considerably more complex.

– A total of 24 measurements must be made at an even number of equally spaced intervals around the circumference (Appendix D/E 13445-3).

– The radial measurements shall be corrected for the mean and for the error in positioning the true centre. This is done by finding the coefficients b0, b1, a1, etc., in the Fourier series expansion of the measurements.

– The maximum departure $W_{max.}$ from the mean circle must be established. The conditions (equation E-6) are met if the vessel is within the 0.5 % tolerance.

As all the measurements have to be made at an even number of equally spaced intervals, the measuring area level must be defined or the alignment of the measuring instrument must be exact. The results are put into a matrix and the maximum deviation is ascertained using a complex calculation procedure.

Discussion

What is the procedure in the various States?

How hard and fast is the method of measuring? Which alternative methods may be used?

The informative Appendix D contains 3 measuring procedures for verifying the shape of the vessel. In the normative Appendix E, the ascertainment of the true centre is only specified for one of the procedures.

So are other procedures allowed (and if so, which?)