

Committee of Experts on the Transport of Dangerous Goods and on the Globally Harmonized System of Classification and Labelling of Chemicals

Sub-Committee of Experts on the Transport of Dangerous Goods

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Item 2 (b) (iii) of the provisional agenda

Recommendations made by the Sub-Committee at its sixty-second, sixty-third and sixty-fourth sessions and pending issues: Explosives and related matters: Review of tests in parts I, II and III of the MTC

Proposed changes to the Koenen test specifications

Transmitted by the experts from the United Kingdom of Great Britain
and Northern Ireland and the United States of America

I. Background

1. This document provides an underlined/strikethrough version of the changes to the Manual of Tests and Criteria proposed in document ST/SG/AC.10/C.3/2024/103.

II. Sustainable Development Goals (SDGs)

2. The work of the ICG is focused on contributing to Sustainable Development Goal 16, *Peace, justice and strong institutions, Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.*

3. In particular by providing greater clarity on the consumables and procedures necessary to effectively and reliably undertake Koenen tests it will:

(a) Develop effective, accountable and transparent institutions at all levels (SDG target 16.6); and

(b) Broaden and strengthen the participation of developing countries in the institutions of global governance (SDG target 16.8).

III. Proposals

4. New text is shown in underlined and deleted text is shown in strikethrough. Where footnotes are added, renumber the existing footnotes appropriately. Amend the *Manual of Tests and Criteria* to read as follows:

(a) In 11.5.1.2.1:

11.5.1.2 *Apparatus and materials*

11.5.1.2.1 The apparatus consists of a non-reusable steel tube, with its re-usable closing device, installed in a heating and protective device. The tube is deep drawn from sheet steel conforming to specification DC04 (EN 10027-1), or equivalent A620 (AISI/SAE/ASTM), or equivalent SPCEN (JIS g 3141).¹ The dimensions are given in figure 11.5.1.1. The open end of the tube is flanged. The closing plate with an orifice, through which the gases from the decomposition of the test substance escape, is made from heat-resisting chrome steel and is available with the following diameter holes: 1.0 - 1.5 - 2.0 - 2.5 - 3.0 - 5.0 - 8.0 - 12.0 -

20.0 mm. The dimensions of the threaded collar and the nut (closing device) are given in figure 11.5.1.1.

For quality control of the steel tubes, 1 % of the tubes from each production lot shall be subjected to quality control and the following data shall be verified:

- (a) The mass of the tubes shall be ~~26.5 ± 1.5 g~~ 27.5 ± 3 g, tubes to be used in one test sequence shall not differ in mass by more than 1 g;
- (b) The length of the tubes shall be 75 ± 0.5 mm;
- (c) The wall thickness of the tubes measured 20 mm from the bottom of the tube shall be ~~0.5 ± 0.05 mm~~ 0.65 ± 0.1 mm; and
- (d) The bursting pressure as determined by ~~quasi-static~~ dynamic load through an ~~incompressible fluid~~ liquid shall be 29 ± 4 MPa. The dynamic bursting pressurization rate is defined as a continuous and rapid pressure rate (i.e., 5-35 MPa in less than 0.5 seconds). The "Dynamic Burst Pressure Test Procedure" is located in Section A.12.2 of Appendix A.12.

Footnote ¹ Tubes manufactured from sheet steel not meeting these specifications may be used provided conditions a-d are met and the tubes are qualified as having the required limiting diameters listed in Section A.12.3 of Appendix A.12.

(b) In 12.5.1.2.1

12.5.1.2 Apparatus and materials

12.5.1.2.1 The apparatus consists of a non-reusable steel tube, with its re-usable closing device, installed in a heating and protective device. The tube is deep drawn from sheet steel conforming to specification DC04 (EN 10027-1), or equivalent A620 (AISI/SAE/ASTM), or equivalent SPCEN (JIS g 3141).¹ The dimensions are given in figure 12.5.1.1. The open end of the tube is flanged. The closing plate with an orifice, through which the gases from the decomposition of the test substance escape, is made from heat-resisting chrome steel and is available with the following diameter holes: 1.0 - 1.5 - 2.0 - 2.5 - 3.0 - 5.0 - 8.0 - 12.0 - 20.0 mm. The dimensions of the threaded collar and the nut (closing device) are given in figure 12.5.1.1.

For quality control of the steel tubes, 1 % of the tubes from each production lot shall be subjected to quality control and the following data shall be verified:

- (a) The mass of the tubes shall be ~~26.5 ± 1.5 g~~ 27.5 ± 3 g, tubes to be used in one test sequence shall not differ in mass by more than 1 g;
- (b) The length of the tubes shall be 75 ± 0.5 mm;
- (c) The wall thickness of the tubes measured 20 mm from the bottom of the tube shall be ~~0.5 ± 0.05 mm~~ 0.65 ± 0.1 mm; and
- (d) The bursting pressure as determined by ~~quasi-static~~ dynamic load through an ~~incompressible fluid~~ liquid shall be 29 ± 4 MPa. The dynamic bursting pressurization rate is defined as a continuous and rapid pressure rate (i.e., 5-35 MPa in less than 0.5 seconds). The "Dynamic Burst Pressure Test Procedure" is located in Section A.12.2 of Appendix A.12.

Footnote ¹ Tubes manufactured from sheet steel not meeting these specifications may be used provided conditions a-d are met and the tubes are qualified as having the required limiting diameters listed in Section A.12.3 of Appendix A.12.

(c) In 18.6.1.2.1

18.6.1.2.1 Apparatus and materials

18.6.1.2.1 The apparatus consists of a non-reusable steel tube, with its re-usable closing device, installed in a heating and protective device. The tube is deep drawn from sheet steel conforming to specification DC04 (EN 10027-1), or equivalent A620 (AISI/SAE/ASTM), or equivalent SPCEN (JIS G 3141).¹ The dimensions are given in figure 18.6.1.1. The open end of the tube is flanged. The closing plate with an orifice, through which the gases from the decomposition of the test substance escape, is made from heat-resisting chrome steel and is available with numerous sized orifices. For this test the following diameter holes are used:

- 1.5 mm for the closing plate used in the heating calibration procedure; and
- 2.0 mm for the closing plate used in the test

The dimensions of the threaded collar and the nut (closing device) are given in figure 18.6.1.1.

For quality control of the steel tubes, 1 % of the tubes from each production lot shall be subjected to quality control and the following data shall be verified:

- (a) The mass of the tubes shall be ~~26.5 ± 1.5 g~~ 27.5 ± 3 g, tubes to be used in one test sequence shall not differ in mass by more than 1 g;
- (b) The length of the tubes shall be 75 ± 0.5 mm;
- (c) The wall thickness of the tubes measured 20 mm from the bottom of the tube shall be ~~0.5 ± 0.05 mm~~ 0.65 ± 0.1 mm; and
- (d) The bursting pressure as determined by ~~quasi-static~~ dynamic load through an ~~incompressible fluid~~ liquid shall be 29 ± 4 MPa. The dynamic bursting pressurization rate is defined as a continuous and rapid pressure rate (i.e., 5-35 MPa in less than 0.5 seconds). The "Dynamic Burst Pressure Test Procedure" is located in Section A.12.2 of Appendix A.12.

Footnote¹ Tubes manufactured from sheet steel not meeting these specifications may be used provided conditions a-d are met and the tubes are qualified as having the required limiting diameters listed in Section A.12.3 of Appendix A.12.

(d) In 25.4.1.2.1:

25.4.1.2.1 *Apparatus and materials*

25.4.1.2.1 The apparatus consists of a non-reusable steel tube, with its re-usable closing device, installed in a heating and protective device. The tube is deep drawn from sheet steel conforming to specification DC04 (EN 10027-1), or equivalent A620 (AISI/SAE/ASTM), or equivalent SPCEN (JIS g 3141).¹ The dimensions are given in figure 25.4.1.1. The open end of the tube is flanged. The closing plate with an orifice, through which the gases from the decomposition of the test substance escape, is made from heat-resisting chrome steel. For classification the following diameter holes shall be used: 1.0 - 1.5 - 2.0 - 2.5 - 3.0 - 5.0 - 8.0 - 12.0 - 20.0 mm. In addition, other diameters can be used for hazard assessment. The dimensions of the threaded collar and the nut (closing device) are given in figure 25.4.1.1.

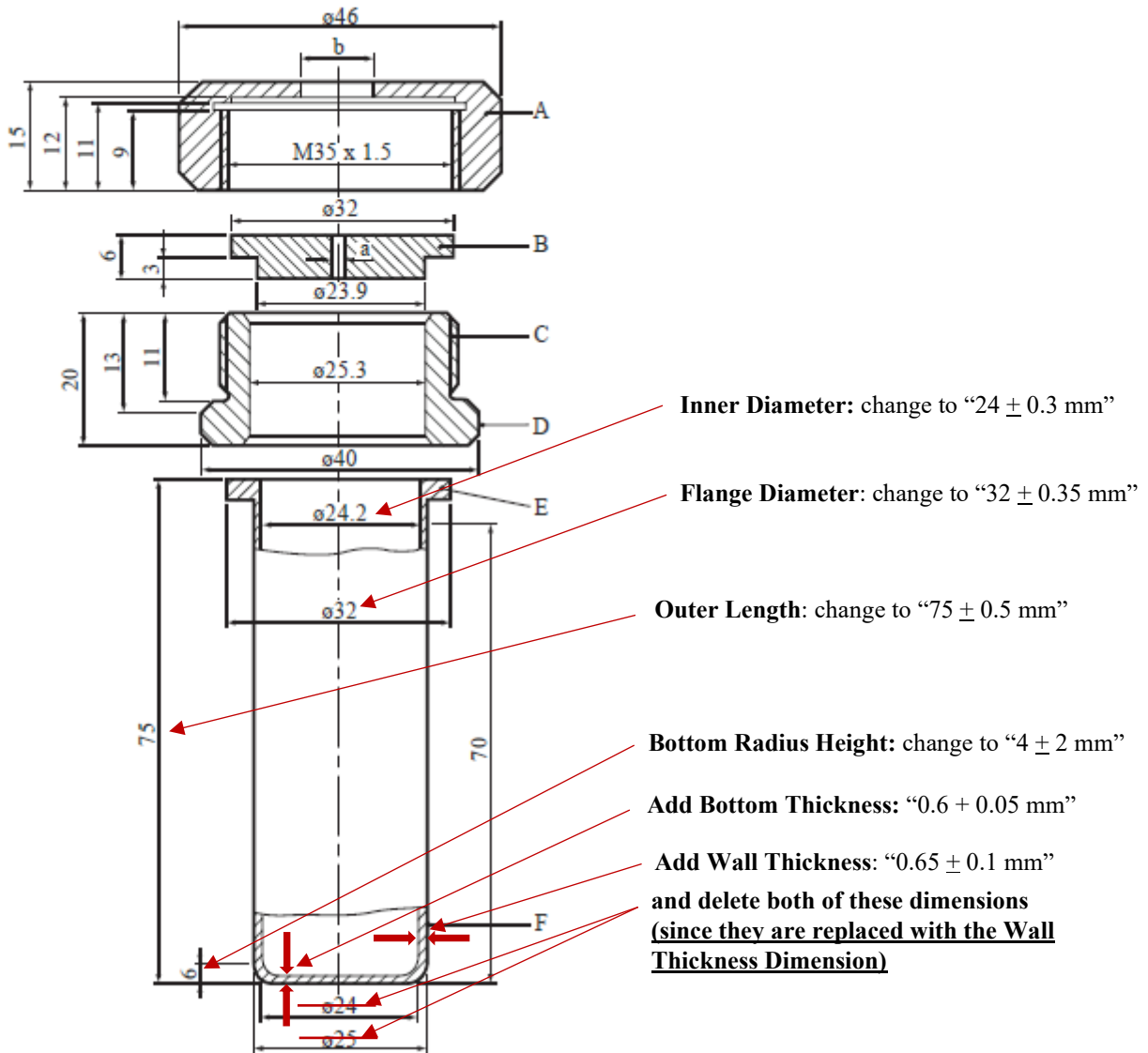
For quality control of the steel tubes, 1 % of the tubes from each production lot shall be subjected to quality control and the following data shall be verified:

- (a) The mass of the tubes shall be ~~26.5 ± 1.5 g~~ 27.5 ± 3 g, tubes to be used in one test sequence shall not differ in mass by more than 1 g;
- (b) The length of the tubes shall be 75 ± 0.5 mm;
- (c) The wall thickness of the tubes measured 20 mm from the bottom of the tube shall be ~~0.5 ± 0.05 mm~~ 0.65 ± 0.1 mm; and
- (d) The bursting pressure as determined by ~~quasi-static~~ dynamic load through an ~~incompressible fluid~~ liquid shall be 29 ± 4 MPa. The dynamic bursting pressurization rate is defined as a continuous and rapid pressure rate (i.e., 5-35 MPa in less than 0.5 seconds).

The “Dynamic Burst Pressure Test Procedure” is located in Section A.12.2 of Appendix A.12.

Footnote ¹ Tubes manufactured from sheet steel not meeting these specifications may be used provided conditions a-d are met and the tubes are qualified as having the required limiting diameters listed in Section A.12.3 of Appendix A.12.

(e) Incorporate the following tube tolerance amendments into Figures 11.5.1.1, 12.5.1.1, 18.6.1.1 and 25.4.1.1. The underlined text is explanatory. Maintain the “key” below the figures.



(f) Add a new appendix to the *Manual of Tests and Criteria* titled “Koenen Tube Qualification Test Procedures”, containing both the Dynamic Burst Pressure Test Procedure and a Table of required Limiting Diameters for use of alternative tube alloys. This new appendix is contained in annex 1 to this document.

Annex I

APPENDIX 12

KOENEN TUBE QUALIFICATION TEST PROCEDURES

A12.1 Introduction

The purpose of this Appendix is to provide sufficient procedural details to (1) obtain accurate dynamic burst pressure test results for quality control of the steel tubes specified by the Koenen Test procedures (Section A12.2), and (2) qualify new tubes produced from alloys other than those specified in Koenen procedures by confirming they will give identical Limiting Diameter results for specified substances (Section A.12.3).

A12.2 DYNAMIC BURST PRESSURE TEST PROCEDURE

A12.2.1 Introduction

This procedure details the test method to determine whether Koenen Tubes manufactured from a variety of manufacturers and manufacturing lots meet the dynamic burst pressure specifications in Sections 11.5.1.2.1(d), 12.5.1.2.1(d), 18.6.1.2.1(d), and 25.4.1.2.1(d) of this *Manual*. The bursting pressure as determined by dynamic load through a liquid shall be 29 ± 4 MPa.

Specific details of the Koenen apparatus are detailed in Tests 1(b), 2(b), 8(c), and Test Method E.1 of this *Manual*.

A12.2.2 Apparatus and materials

The following items are required:

- (a) Burst pressure apparatus (figure A12.2.1) designed to completely purge Koenen tubes of all air and apply pressures of 35 MPa or greater using a non-corrosive liquid. The apparatus is equipped to accept a pressure transducer.
- (b) A static pressure transducer. Any pressure-measuring device may be used provided it is calibrated with a measuring range above the allowable Koenen tube burst pressures detailed in 11.5.1.2.1 (d), 12.5.1.2.1 (d), 18.6.1.2.1 (d), or 25.4.1.2.1 (d) of this *Manual* and has a response time capable of detecting pressure changes at which they will occur during testing.
- (c) A data acquisition (DAQ) system. Used to collect static pressure data with acquisition rate of suitable speed and resolution to accurately assess tube burst pressure. A minimum sampling rate of 10 kHz should be used to ensure peak pressure is captured with accuracy.
- (d) A Koenen tube collar meeting the specifications detailed in Figures 11.5.1.1, 12.5.1.1, 18.6.1.1 of this *Manual*.
- (e) A modified orifice for hydraulic testing. The modified orifice allows connection of the Koenen tube to the burst pressure apparatus.

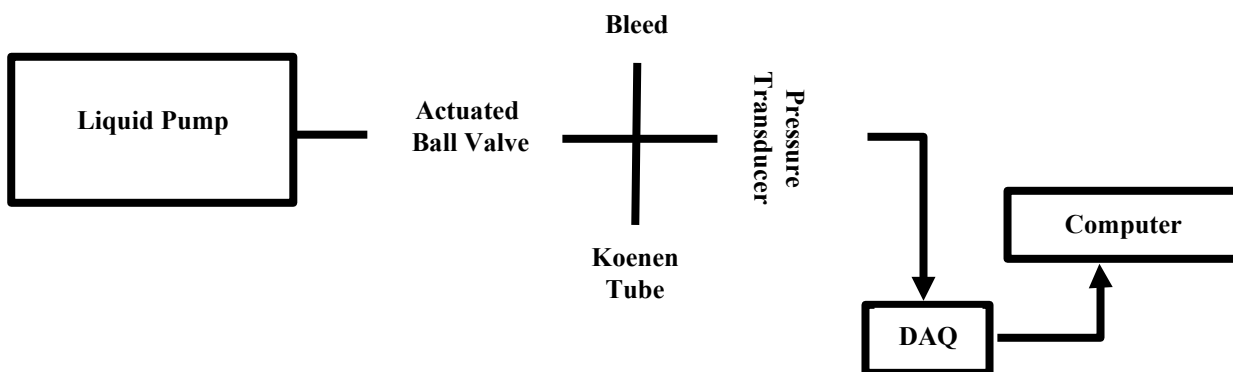
A12.2.3 Procedure

- A12.2.3.1 The burst pressure testing apparatus is set up to purge air from the tube and introduce the test liquid. The pressure transducer and data acquisition system are attached (see Figure A12.1) and tested to verify proper functioning and capability to accurately measure and record pressures above the maximum burst pressures specified in 11.5.1.2.1 (d), 12.5.1.2.1 (d), 18.6.1.2.1 (d), or 25.4.1.2.1 (d) of this *Manual*.
- A12.2.3.2 The Koenen tube is labelled and inserted into the threaded collar with the modified orifice plate on top of the tube, then the collar nut is tightened to provide an effective seal.
- A12.2.3.3 The modified orifice plate is connected to the burst pressure apparatus and placed in a protective area, then connections verified against leaks. The entire system is purged of air, then the vacuum valve is closed and examined for constant pressure. The actuated ball-valve is closed to prevent premature pressurization of the Koenen tube, after which the supply line to the closed valve is charged with the pump to approximately 35 MPa. The ball-valve is opened remotely and gauge pressure at which tube bursts is recorded.

A12.2.4 Test criteria and method of assessing results

- A12.2.4.1 The test results are interpreted in terms of whether the peak pressure recorded by the transducer before **rupture** of the Koenen tube falls within the required pressure range. The result is considered negative (“-“) if the peak pressure is 29 ± 4 MPa and the lot from which the tested tubes were selected is considered to be qualified as meeting the Koenen Test burst pressure specifications.

Figure A12.2.1: Burst Pressure Apparatus setup



A12.3 REQUIRED LIMITING DIAMETERS FOR USE OF ALTERNATIVE TUBE ALLOYS

A12.3.1 Introduction

Tubes manufactured from sheet steel alloys other than those listed in 11.5.1.2.1, 12.5.1.2.1, 18.6.1.2.1 and 25.4.1.2.1 may be used provided that each of the limiting diameters listed in A12.3.2 are met.

A12.3.2 Table of Required Limiting Diameters

Substances	Limiting Diameter
Guanidine Nitrate	1.5 mm
Ammonium Nitrate Powder	1 mm
Tert-Butyl peroxybenzoate	3.5 mm
Diluted tert-Butyl peroxybenzoate with 50 wt% Isododecane	1 mm ¹

Note: The detailed protocol used to determine the limiting diameters given in the table above is available from the national contacts for test details in Germany, United Kingdom or United States of America (see appendix 4).

¹ For a type "A" effect.