Pressure Safety for Pressure and Differential Pressure Process Control Devices

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PRESSURE SAFETY
FOR
PRESSURE AND DIFFERENTIAL PRESSURE PROCESS CONTROL DEVICES

FOREWORD

This Foreword is supplied for informational purposes only and is not part of . Standard Pressure Safety for Pressure and Differential Pressure Process Control Devices,

Standards are adopted in the public interest and are designed to eliminate misunderstandings between the manufacturer and the purchaser and to assist the purchaser in selecting and obtaining without delay the proper product for his particular need. Existence of a Standard does not in any respect preclude any member or nonmember from manufacturing or selling products not conforming with the standard.

It should be emphasized that this standard covers test pressure for safety only. The test would usually be run only once to demonstrate that the designer has used the proper safety factors in specifying metal thickness, bolt sizes, etc. The test would very often be destructive in the sense that pressure elements and other parts could be distorted to the point of being nonfunctional afterwards.

All test pressures are multiples of the maximum rated operating pressure marked on the instrument. In the case of a differential pressure device, this would be the maximum static (working) pressure. In the case of a pressure measuring device, this would normally be the upper range-limit. If the overrange limit (the maximum pressure that can be applied without permanent change in performance) is greater than this, it would not be used as the basis for determining the test pressures unless it were marked on the instrument.

In accordance with approved practice, metric SI units (International System of Units) are utilized throughout this document with English equivalents indicated in parentheses.

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1. SCOPE AND PURPOSE

1.1 GENERAL

1.1.1 This standard specifies pressure safety tests for pressure and differential pressure transmitters, recorders and controllers intended for process measurement and control.

1.1.2 The purpose of this standard is to provide a means by which the pressure safety of a fluid-pressure-actuated device can be verified. It is not intended to apply to common indicating gauges.

1.1.3 This standard is written for use by manufacturers, users, and approval bodies.

1.2 **RANGES COVERED.** This standard is applicable to fluid-pressure-actuated devices employing flexible-metal bellows, diaphragms, Bourbon tubes or the like that are rated for pressures between 2000 and 175 000 kPa (300 and 25,000 pounds per square inch).* Devices rated below 2000 kPa (300 psi) generally offer no pressure safety problem while devices with rated pressures over 175 000 kPa (25,000 psi) are special-purpose devices outside the scope of this standard.

1.3 LIMITATIONS

1.3.1 It is not within the scope of this standard to specify routine testing or testing of duplicate parts of the same materials, design and construction, once a representative single unit has been tested and proven adequate by the means herein specified. Tests are potentially destructive, and the device is not required to be functional after the tests are completed.

1.3.2 The pressure test levels specified in this standard are not intended to verify protection for unusual situations of use. That is, the maximum working pressure marked on the instrument is the highest pressure that the user is ever authorized to use even in an emergency-failure situation. It is recommended that an instrument with a maximum working pressure equal to or greater than the maximum possible failure-mode pressure be used.

2. DEFINITIONS OF TERMS

To facilitate proper interpretation and application of the Test Procedures as listed under Section 3 of this standard, the definitions for several special terms are listed below.

*Nominal or approximate conversion values are used in this standard in the interests of practical usage. See Appendix I.

chamber - This term applies to that part of a device that is normally subjected to the actuating fluid pressure. This includes chambers that are subjected directly to an actuating fluid pressure as well as those that receive indirect pressure loading such as developed in hydraulically coupled systems.

dangerous rupture - Rupture or failure which results in flying fragments outside of the device.

enclosure - An unpressured case, cover, housing, etc., which may enclose all or part of the device. The enclosure part of the device is not subjected to the actuating fluid pressure.

structural partition - That part of a device which serves as a barrier between the pressure chamber and the external components.

3. TEST PROCEDURES*

3.1 INITIAL HYDROSTATIC TESTS

Note: With differential-pressure devices hydrostatic test pressures are to be applied to both sides simultaneously.

3.1.1 The device shall withstand for one minute without visible leakage, a hydrostatic pressure applied to the chamber in accordance with the pressures listed in Table I, Col. II.

3.1.2 The device shall withstand for one minute without dangerous rupture, a hydrostatic pressure applied to the chamber in accordance with the pressures listed in Table I, Col. III.

Leakage may occur because of splits in Bourdon tubes, diaphragms or bellows and because of joint and/or gasket failure; however, the device is acceptable if:

(1) The required hydrostatic pressure listed in Table I, Col. III is developed and maintained in the chamber for one minute, and

(2) There are no flying fragments outside of the device.

3.2 HYDROSTATIC TESTS FOR MODIFIED DEVICES

3.2.1 If excessive leakage prevents the development of the required hydrostatic pressure in Table I, Col. III, certain device modifications are allowed:

(1) External fittings may be modified to eliminate leakage.

(2) A leaking gasket or flexible seal member (not part of the measuring element) may be replaced on the device by a stronger nonfunctional member such that the

strength of the chamber and structural partition can be demonstrated by meeting the requirements of 3.1.2. For example, a sealing diaphragm may be replaced by a heavier disc. Any replacement of elements in the structural partition which separates the chamber and the enclosure must also meet the requirements of 3.3.2.

3.3 HYDROSTATIC TESTS UNDER CONDITIONS OF EXCESSIVE LEAKAGE

3.3.1 If excessive leakage cannot be reduced by modification of the device as allowed under Section 3.2.1 and as a result the hydrostatic pressures as listed in Table I, Col. III cannot be reasonably achieved, the device is acceptable if the following criteria are met:

(1) If the device has no enclosure it shall withstand for one minute, without flying fragments, a hydrostatic pressure as listed in Table I, Col. IV.

(2) If the device has an enclosure, the device shall withstand for one minute, without flying fragments, a hydrostatic chamber pressure as listed in Table I, Col. IV and the device must also meet the requirements of Section 3.3.2.

3.3.2 For a device which contains an enclosure and is tested under conditions of excessive leakage as covered by 3.3.1 (2) or for a device with modifications in the structural partition as allowed under 3.2.1, one of the following requirements must also be met:

(1) It must be demonstrated by test that the enclosure can relieve at an adequate rate, a pressure equal to the maximum marked operating-pressure rating of the device without dangerous rupture.

OR

(2) It must be demonstrated by test that the enclosure can withstand a pressure equal to the maximum marked operating-pressure rating without dangerous rupture.

OR

(3) It must be demonstrated that the unaltered structural partition separating the chamber and the enclosure can withstand without leaks, a hydrostatic pressure in accordance with Table I, Col. IV.

*The normal testing sequence is also shown in the flow chart of Appendix II.

TABLE I

TEST PRESSURES

COL. I	COL. II	COL. III	COL. IV
Marked Maximum Operating Pressure Rating	Test Pressures for Paragraph 3.1.1	Test Pressures for Paragraph 3.1.2	Test Pressures for Paragraph 3.3.1
2 000 - 14 000 kPa (300 - 2,000 psig)	2.0 times rated [(a)] pressure	3.0 times rated [(a)] pressure	2.5 times rated [(a)] pressure
Over 14 000 - 70 000 kPa (Over 2,000 - 10,000 psig)	1.75 times rated [(a)] pressure plus 3 500 kPa (500 psi)	2.5times rated [(a)] pressure plus 7 000 kPa (1,000 psi)	2.0 times rated [(a)] pressure plus 7 000 kPa (1,000 psi)
Over 70 000 - 175 000 kPa (Over 10,000 - 25,000 psig)	1.3 times rated [(a)] pressure plus 35 000 kPa (5,000 psi)	2.0 times rated [(a)] pressure plus 42 000 kPa (6,000 psi)	1.5 times rated [(a)] pressure plus 42 000 kPa (6,000 psi)

(a) - marked maximum operating-pressure rating

APPENDIX I

PRESSURE CONVERSIONS (APPROXIMATE)*

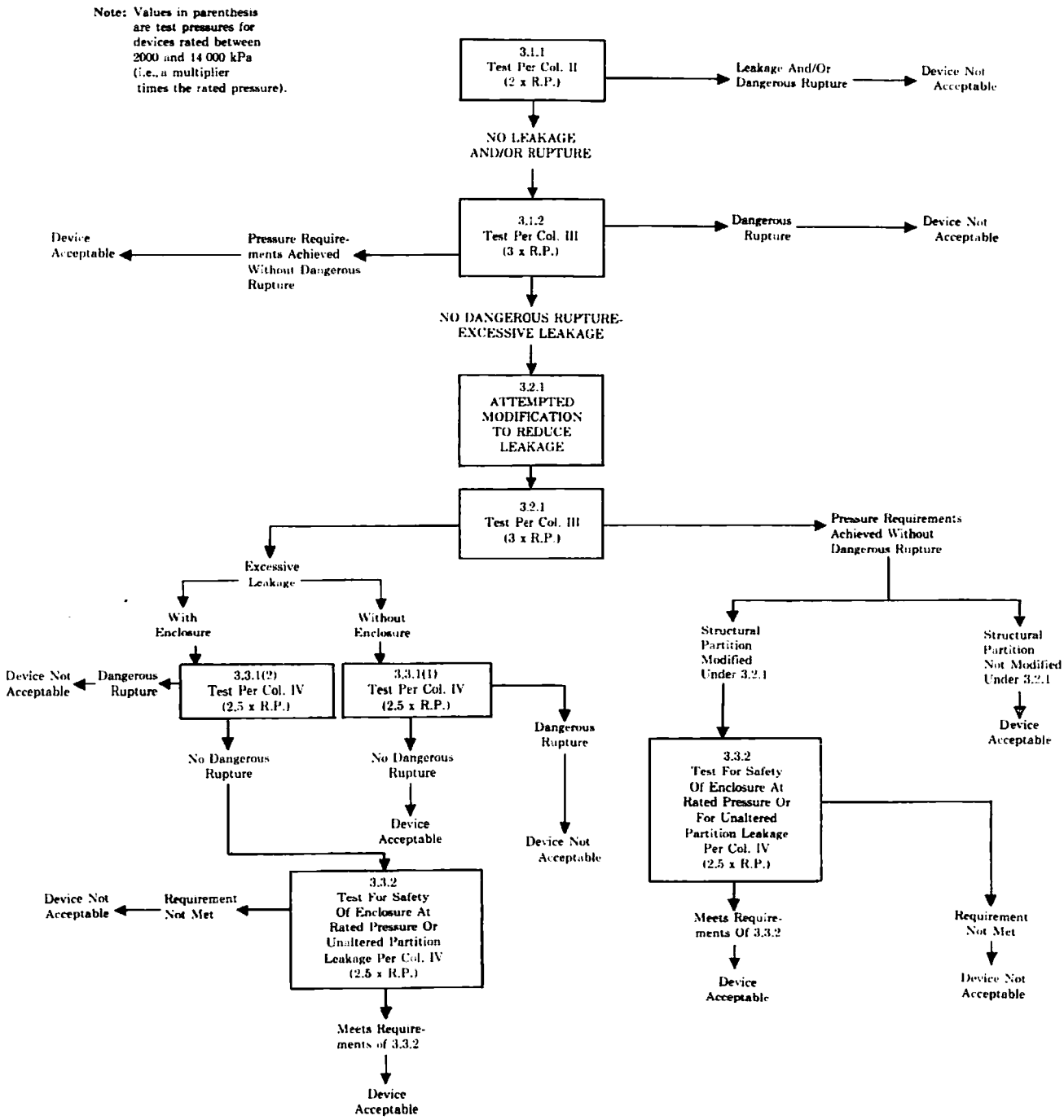
kilopascals (kPa)	psi
2 000	300
3 500	500
7 000	1,000
14 000	2,000
35 000	5,000
42 000	6,000
70 000	10,000
175 000	25,000

In the metric system, a space replaces the coma as the thousands marker. However, it is not required for four digits except in tabulations in which some values exceed four digits.

*Exact conversions may be determined from the relationship: 1 kPa = 0.1450 psi.

APPENDIX II

FLOW CHART FOR TEST PROCEDURES



APPENDIX III

SOURCES AND REFERENCES

In the preparation of this standard, standards and related publications issued by technical societies and organizations were reviewed. The documents pertaining to this standard are referenced below:

The scope of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 does not include vessels of the size ordinarily used in the equipment covered by this standard (Par, U-1 (d) 5). However, the design rules in Division 1 can be applied to demonstrate the adequacy of bolted flange connections.

Copies of the ASME Publication referred to above may be purchased from the American Society of Mechanical Engineers, 345 East 47th Street, New York, N.Y. 10017.

British Standards BS4509 and BS3512 include sections on "Strength of Parts" which appear to have the same purpose as that of this standard. These British standards are listed as references, but their test specifications are not used directly. In general, they cover performance specifications, rather than proof of product pressure safety.

Copies of the BS Publications referred to above may be purchased from the American National Standards Institute, Inc., 1430 Broadway, New York, N.Y. 10018.

Federal Specification GG-G-76c for Gages, Pressure and Vacuum, Dial Indicating, is another reference, but not a direct source. Its Section 3.5.3 appears to be a check on the effect on performance resulting from over-pressure. Its provisions appear to be too permissive when viewed as a proof of safety of pressure-measuring or pressure-controlling devices.

Copies of the FS Publication referred to above may be purchased from the General Services Administration, Standardization Division, Crystal Mall, Washington, D.C. 20405.

Military Specification, Indicator, Pressure, Panel Mounted or Case Supported, General Specification, MIL-I-18997C (ships) has a Section 3.5.4 dealing with over-range test pressuring of pressure indicators. This is obviously designed as an inspection code rather than as a proof of pressure safety. This MIL specification is used as a reference, therefore, but not as a direct source of material for this standard.

Paragraph 4.6.9.1 "Rupture" in this MIL specification describes a means of testing enclosures for the effect of failure of pressure containing elements inside the enclosure. The results of a test as therein specified are not believed to be a meaningful indication of the safety of the devices covered by this standard, and therefore, such a test is not specified herein.

Copies of the MIL Publication referred to above may be purchased from the Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

Underwriters' Laboratories, Inc. Standard UL 913,Intrinsically Safe Electrical Circuits and Equipment for Use in Hazardous Locations, First Edition (Nov. 30, 1971) contained, in Paragraphs 77 through 84, specifications intended to serve the purpose of this standard. The specifications and language of that edition of the UL standard have, in part, been incorporated in this standard. (The First Edition is out of print).

Information on the UL Publication referred to above may be obtained from the Underwriters' Laboratories, Inc., 333 Pfingsten Road, Northbrook, Illinois 60062.