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**Recommended contents for pressure
balance calibration certificates
(part of EUROMET Project 220)**

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ABSTRACT

This Recommendation was prepared by representatives of 9 national standards laboratories participating in EUROMET Project 220 (the calculation and expression of the uncertainties of pressure balances). Hitherto all participating laboratories have provided slightly different information on their calibration certificates/reports. 132 possible items of information have been segregated into 2 groups - 61 items agreed as essential and 71 as optional.

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Approved on behalf of Chief Executive, NPL,
by Dr A R Colclough, Head, Division of Mechanical & Optical Metrology

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1 INTRODUCTION

The following Recommendation has been prepared by the participants of EUROMET Project 220 (the calculation and expression of the uncertainties of pressure balances) because it was evident that the information provided on pressure balance calibration certificates issued by national standards laboratories has varied very significantly from one country to another.

The participants of the project were as follows:

CEM, Spain	Dr S Palomino Dr J A Robles
DANTEST, Denmark	Mr J G Blom Mr H H Ploug
FFA, Sweden	Mrs C Bergström
LNE, France	Mr J C Legras
IMGC, Italy	Dr G-F Molinar
NPL, UK	Dr P R Stuart (Coordinator and Secretary) Mr D I Simpson Mr M R White
PTB, Germany	Dr J Jäger
TTK, Finland	Mr M Rantanen
VSL, Netherlands	Dr R M Muijlwijk

The items listed below indicate the wide range of information that may appear on calibration certificates. These items have been categorised and further subdivided into 2 groups - those items which the Project participants have agreed to be essential and those which are regarded as optional. The essential items are the minimum that it would be necessary to provide to a customer seeking accreditation, in order that he in turn can provide his assessor with sufficient evidence of traceability and of measurement uncertainty.

It is assumed that in national standards laboratories pressure balances are invariably calibrated by cross-floating, ie by hydrostatic balancing against a pressure balance of higher accuracy.

2 GENERAL INFORMATION

2.1 ESSENTIAL INFORMATION

- Name of the calibration laboratory
- Position or status of the calibration laboratory within its national measurement system
- Certificate reference number, printed on every sheet
- Date of completion of calibration
- Date of issue of certificate
- Signature and printed name of the technical manager of the calibration laboratory
- Page number of every sheet, preferably in the form "Page X of Y".

2.2 OPTIONAL INFORMATION

- Calibration laboratory's job number
- Names of the calibrating staff
- Signature or initials of the checker of the calibration results
- Signature of the laboratory director.

3 DESCRIPTION OF THE INSTRUMENT CALIBRATED

3.1 ESSENTIAL INFORMATION

- Name of the organisation requisitioning the calibration
- Address of the organisation requisitioning the calibration
- Name of the manufacturer of the instrument calibrated
- Model or type description
- Description or serial number of the base used and whether it belongs to the calibration laboratory or to the customer
- Serial number of the piston
- Serial number of the cylinder, if different from that of the piston
- Method of lubrication, if gas-operated
- Serial numbers of any components whose mass is included on the certificate, eg for some instruments the weight carrier
- Serial numbers of any other components which influence the results of the calibration
- Assumed density of the piston and of the weight carrier
- Assumed density of any ring-weights included on the certificate.

3.2 OPTIONAL INFORMATION

- Customer's order number
- Name of a contact person within the customer's organisation
- Trademark
- Nominal effective area
- Nominal maximum pressure
- Nominal minimum pressure
- Whether the cylinder is simple or re-entrant
- Materials of the ring-weights, if the customer's ring-weights used
- Maximum load.

4 CALIBRATION EQUIPMENT

4.1 ESSENTIAL INFORMATION

Source of traceability.

4.2 OPTIONAL INFORMATION

Serial number of the piston-cylinder assembly of the standard

Serial number of the base of the standard

- Nominal effective area of the standard
- A_0 , the effective area at zero applied pressure, of the standard
- Uncertainty of A_0 of the standard
- Distortion coefficient of the standard
- Uncertainty of the distortion coefficient of the standard
- Uncertainty of the effective area of the national primary standard
- Uncertainty of the distortion coefficient of the national primary standard.

5 RECORD OF PRE-CALIBRATION CHECKS

5.1 ESSENTIAL INFORMATION

Method of cleaning, if different from the manufacturer's recommendation

Statement as to whether the levelling device on the customer's base was checked.

5.2 OPTIONAL INFORMATION

- Method of visual inspection and conclusions
 - Result of check for freedom of vertical mobility
 - Whether the spin time was measured and at which loading or pressure
 - Whether the fall rate was measured and at which loading or pressure
- Results of check for clockwise/anti-clockwise rotation differences, except in instruments in which rotation is produced by a unidirectional electric motor
- The result of any check made for magnetisation, and a statement of any remedial action found to be necessary.

6 CALIBRATION CONDITIONS AND PROCEDURES

6.1 ESSENTIAL INFORMATION

Mode of operation during calibration (absolute or gauge)

How the instrument was levelled

Fluid used for calibration. If oil, the name and type should be stated

Assumed value, with limits, for the density of the fluid used during calibration (oil only)

Assumed value, with limits, for the surface tension of the fluid (oil only)

Assumed thermal expansivity, with limits, of the piston and cylinder combination

The reference (datum) level of the instrument being calibrated

The height of the piston relative to the cylinder at which crossfloat observations were taken

The tested pressure range

The certified pressure range, and any reason for it being less than the tested or nominal pressure range

- Whether the cross-float procedure followed the direct or the incremental method
- The method of rotating the weights
- The range of speed of rotation during calibration, unless motor driven
- Whether clockwise, anticlockwise or both rotations were used
- The number of nominal pressures in the calibrated range
- Whether the nominal pressures were evenly spaced throughout the calibrated range
- The number of independent observations at each pressure or the total number (Note: Clockwise/anticlockwise measurements taken in pairs may not be totally independent of one another)
- The worst-case (highest) bell-jar pressure during absolute mode calibrations
- The lowest bell jar pressure during absolute mode calibrations
- Any other data needed to calculate the total uncertainty.

6.2 OPTIONAL INFORMATION

Range of ambient temperature during calibration

Range of temperature of the cylinder of the instrument being calibrated, during the calibration

- The mean or range of ambient pressure during calibration
- The range of ambient relative humidity during calibration
- The value of acceleration due to gravity at the calibration laboratory
- The difference in height between the reference planes of the standard and the instrument calibrated

The assumed viscosity of the fluid used in the calibration (oil only)

A statement that the calibration of instrument is not traceable outside the certified range and that the uncertainties outside this range shall not be assumed to be similar to those within the certified range.

7 CALIBRATION RESULTS

7.1 RESULTS EXPRESSED IN TERMS OF EFFECTIVE AREA

7.1.1 Essential information

- The reference temperature for which A_0 or A_p were calculated
- The equation chosen to express the dependence of A_p on applied pressure
- The effective area A_0
- The pressure-dependent term (distortion coefficient), if significant
- The uncertainty in A_0 and the uncertainty coverage-factor k
- The uncertainty in the pressure-dependent term (distortion coefficient), if significant, and the uncertainty coverage-factor k

A statement on whether the above uncertainties are solely as calculated from the measurements or whether they include additional allowances for setting-up variations and for anticipated degradation and wear

The mass measurement convention

- The mass and the uncertainty of the mass of the piston and weight-carrier
- The masses and the uncertainties of the masses of the ring weights, if these are included in the calibration

The calculated buoyancy volume of the piston (oil only)

The calculated surface tension force on the piston (oil only).

7.1.2 Optional information

- The measured value of the spin time at a specified loading or pressure
- The measured value of the fall rate at a specified loading or pressure
- A table of test pressure and the corresponding values of A_p for each crossfloat measurement
- The mean value of A_p for each nominal pressure or ring-weight combination
- The experimental standard deviations of the mean values of A_p
- The calculated values of the pressures which would have been generated under stated reference conditions of temperature and gravity when the piston was loaded with specified ring-weight combinations
- The calculated buoyancy force on the piston (oil only)
- A reminder that the buoyancy force acts upwards (oil only)
- A reminder that surface tension force acts downwards (oil only).

7.2 CALIBRATION RESULTS EXPRESSED IN TERMS OF PRESSURES RATHER THAN EFFECTIVE AREA

7.2.1 Essential information

- The mean values of pressure required, under defined conditions of temperature and gravity, to support the position, the weight-carrier and stated combinations of ring-weights or, alternatively, the mean differences between these pressures and the expected or intended values, ie the mean errors in pressure
- The number of observations on which the above mean pressure values were based
- The uncertainties of the mean pressure values, with the corresponding uncertainty coverage-factor k
- The reference temperature and the value of gravity for which the above pressures were calculated
- An equation enabling pressures to be calculated for other temperatures and for local gravity
- A statement on whether the above uncertainties are solely as calculated from measurements or whether they include additional allowances for setting-up variations, for anticipated degradation, wear or any other factors.

7.2.2 Optional information

- The repeatabilities (experimental standard deviations) of the generated pressures
- The differences between the measured pressures and the corresponding nominal pressures
- The effective area A_p for the stated combinations of ring weights
- The uncertainty in the values of A_p and the uncertainty coverage-factor k
- An equation expressing the dependence of A_p on applied pressure
- The effective area at zero applied pressure A_0
- The uncertainty in A_0 and the uncertainty coverage-factor k
- The pressure-dependent term (distortion coefficient)
- The uncertainty in the pressure-dependent term (distortion coefficient) and the uncertainty coverage factor k
- The reference temperature for which A_0 or A_p were calculated
- The mass measurement convention
- The mass and the uncertainty of the mass of the piston and weight-carrier
- The masses and the uncertainties of the masses of the ring weights, if these are included in the calibration
- The calculated surface tension force on the piston (oil only)
- The measured value of the spin time at a specified loading or pressure

The measured value of the fall rate at a specified loading or pressure

A table of values of A_p and corresponding test pressures for each crossfloat measurement

The mean value of A_p for each nominal pressure or ring-weight combination

The uncertainties of the mean values of A_p and the coverage-factor k used

- The buoyancy volume of the piston (oil only)
- A reminder that the buoyancy force acts upwards (oil only)
- A reminder that the surface tension force acts downwards (oil only).