28-Apr-2023

Good Weighing Practice(GWP)

ACC & USP

Kassakorn

Tassanachaisakul

METTLER TOLEDO

Agenda

1	Accuracy Calibration Certificate : ACC
2	EURAMET: Contributions to the Uncertainty of EOI
3	Evaluation of Balance
4	Good Weighing Practice (GWP)
5	USP Chapter 1251
6	USP Chapter 41
7	Minimum Weight from USP and GWP
8	GWP Verification
9	Routine operation

Euramet cg-18

Guidelines on the Calibration of Non-Automatic Weighing Instruments

EURAMET Calibration Guide No. 18
Version 4.0 (11/2015)

EURAMET

Euramet cg-18

Calibration of non-automatic weighing instruments (NAWI)

Non-automatic weighing instruments have become ubiquitous for applications in the laboratory, on the production floor and in many other business areas (retail, pre-packaging, vehicle weighing, etc.). Due to their importance, calibration guidelines have been developed by many different organizations, especially since electronic weighing instruments were established on the market. Traditionally, these calibration guidelines were applied on a national level as the underlying issuing organizations were either national metrology institutes, national accreditation bodies or other nationally recognized organizations.

As a consequence of an effort to harmonize the requirements for the calibration of NAWIs on an international level, the guideline EURAMET cg-18 "Guidelines on the calibration of non-automatic weighing instruments" was developed by the leading European metrology institutes. It is now widely applied by calibration laboratories in Europe, and many national accreditation bodies take it as the state-of-the-art reference for accreditation of calibration laboratories7. The guide has been adopted by SIM (Sistema Interamericano de Metrología) and thus is formally recognized by the regional American metrology organizations. Furthermore, it is also applied by several calibration laboratories in Africa and Asia, however not yet systematically.

Due to its widespread use, the EURAMET cg-18 calibration guide is the most frequently used reference document for the calibration of NAWIs. There are recent activities in the US, triggered by ASTM, who are interested in taking over the methodology of cg-18 and transposing it into an ASTM standard, which could potentially serve as a future national calibration guide for the US.

Why Do We Calibrate ?

Why do we calibrate balance?

A

Because my auditor asks to see the calibration certificate

B

Because I use the data to show the balance fulfill my accuracy requirement

Why Do We Calibrate ?

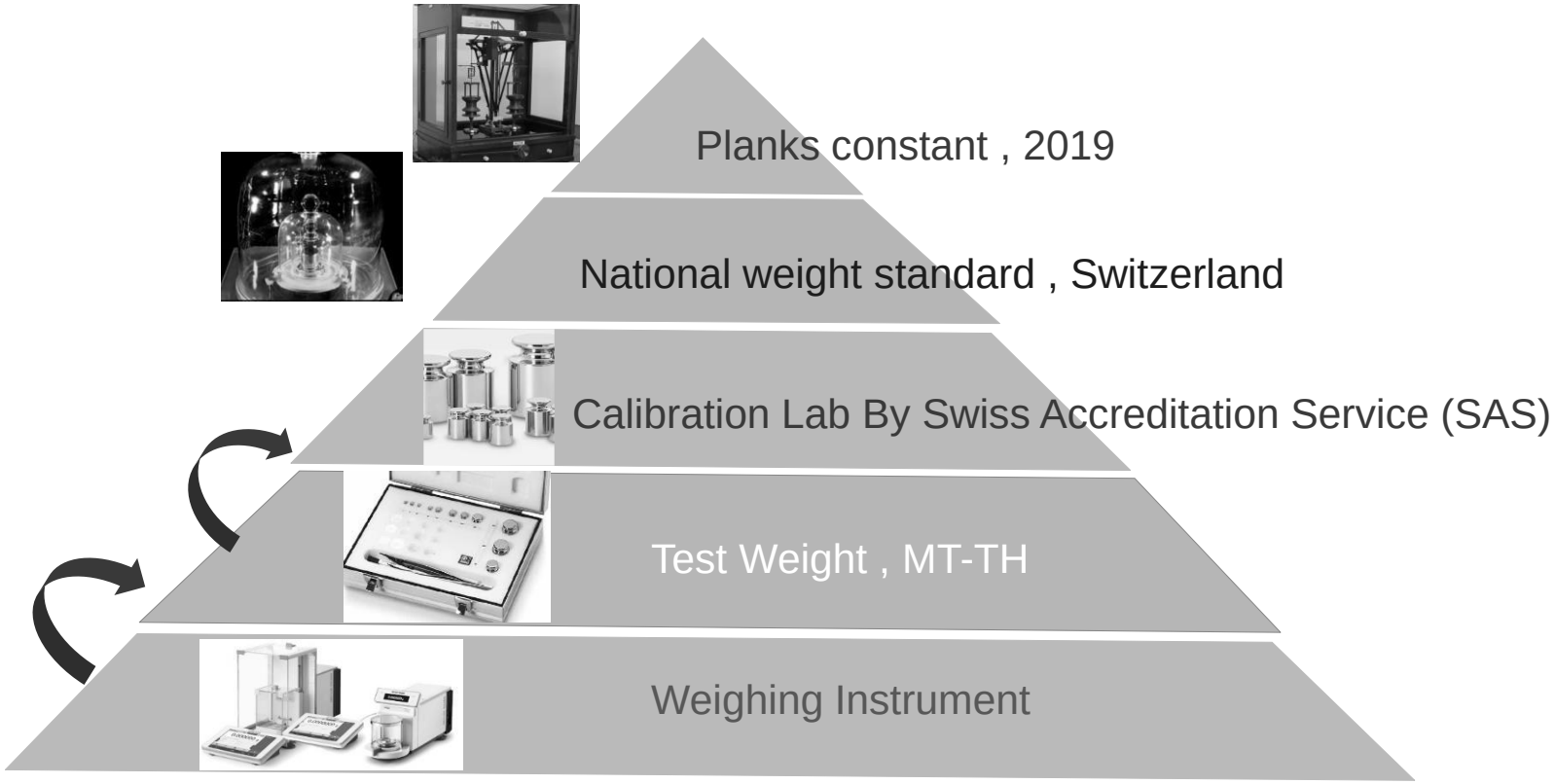
To Understand the behavior of the instrument

Know how accurate our measurements

really are determined of measurement uncertainty

Establish metrological traceability to the SI unit kg

Traceability to the SI unit kg



Accuracy

A weighing instrument is **accurate,**

if it meets the user's process and quality requirements, i.e. if:

Measurement Uncertainty

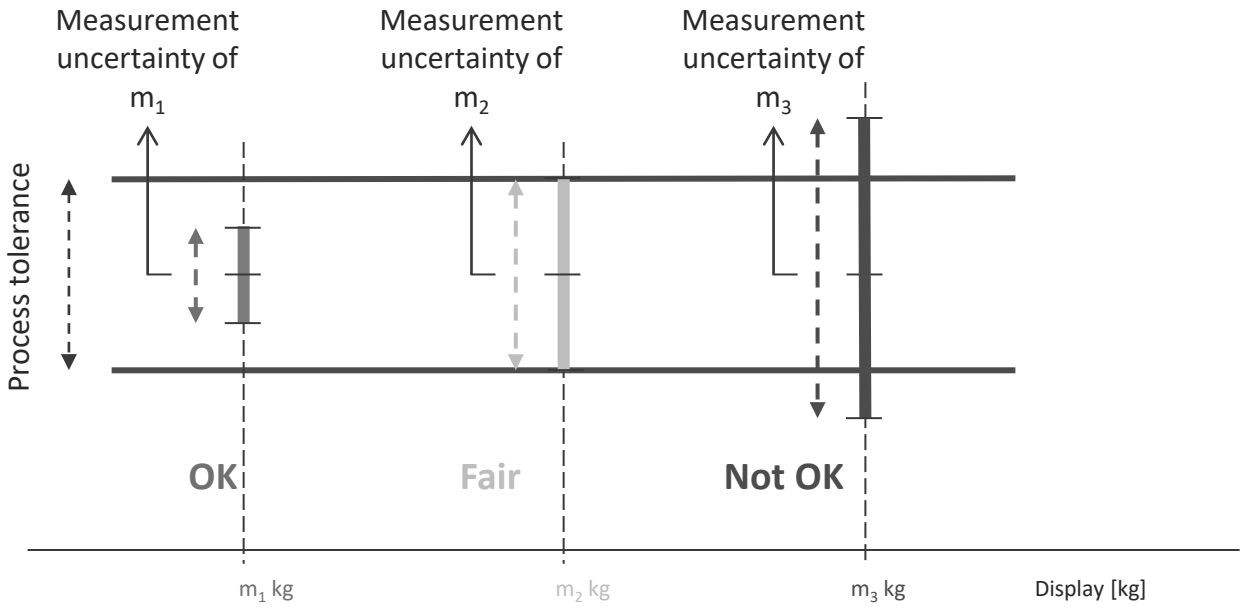
Calibration

≤

Weighing Process Tolerance

User Requirement

Accuracy



Accuracy means that the MEASUREMENT UNCERTAINTY of the instrument is always less than/equal to the PROCESS TOLERANCE.

EURAMET: Contributions to the Uncertainty of EOI

$$u^2(E) = d_0^2/12 + d_I^2/12 + s^2(I) + u^2(\delta I_{ecc})$$ **FROM DEVICE**

$$+ u^2(\delta m_c) + u^2(\delta m_B) + u^2(\delta m_D) + u^2(\delta m_{conv})$$ **FROM WEIGHTS**

$d_0 / \sqrt{12}$	Rounding error of no-load indication
$d_I / \sqrt{12}$	Rounding error of indication at load
s	Repeatability (standard deviation)
$u(\delta I_{ecc})$	Eccentricity (off-centre position)
$u(\delta m_c)$	Weight uncertainty (alternatively: max. permissible error)
$u(\delta m_B)$	Uncertainty due to air buoyancy
$u(\delta m_D)$	Uncertainty due to drift of weight value over time
$u(\delta m_{conv})$	Uncertainty due to convection

MEASUREMENTS

Accuracy Calibration Certificate page 1 of 5

Calibration Certificate ID
TH2020-032-061421-ACC-TH

METTLER TOLEDO

Mettler-Toledo (Thailand) Ltd.
846/4 - 846/5 Lasalle Rd., Bangna Tai Sub-District
Bangna District, Bangkok 10260
+66 2723 0382
MT-TH.ServiceSupport@mt.com

NSC-TISI-TIS 17025
CALIBRATION 0062

Accuracy Calibration Certificate

Customer

Company:	N/A		
Address:	Bangpoo Industrial Estate (North), Praksa Mai		
City:	Muang	Contact:	N/A
Zip / Postal:	10280		
State / Province:	Samut Prakan		
Order Number:			

Weighing Device

Manufacturer:	Mettler Toledo	Instrument Type:	Weighing Instrument
Model:	MS204S/01	Asset Number:	QC-EL-04
Serial No.:	B349068957	Terminal Model:	N/A
Building:	N/A	Terminal Serial No.:	N/A
Floor:	1	Terminal Asset No.:	N/A
Room:	QC Lab.		

1&2

Range	Max. Capacity	Readability (d)
1	220 g	0.0001 g

Procedure

Calibration Guideline: EURAMET cg-18 v. 4.0 (11/2015)
METTLER TOLEDO Work Instruction: CP/W002/20

This calibration certificate contains measurements for As Found and As Left calibrations.
The sensitivity/span of the weighing instrument was adjusted before As Found and As Left calibrations with a built-in weight.
In accordance with EURAMET cg-18 (11/2015), the test loads were selected to reflect the specific use of the weighing device or to accommodate specific calibration conditions.

	Temperature		Humidity	
As Found	Start: 23.3 °C	End: 23.6 °C	Start: 51.6 %	End: 51.2 %
As Left	Start: 23.7 °C	End: 23.3 °C	Start: 52.4 %	End: 53.4 %

As Found Calibration Date: 14-Jun-2021
As Left Calibration Date: 14-Jun-2021
Issue Date:

Calibrator: Kassakorn Tassanachaisakul

Approved Signatory:

☐ Kassakorn Tassanachaisakul

Calibration Laboratory Data

Certificate Name

Customer Data

Weighing Data

$d_0 / \sqrt{12}$ Rounding error of no-load indication

$d_I / \sqrt{12}$ Rounding error of indication at load

Calibration Procedure

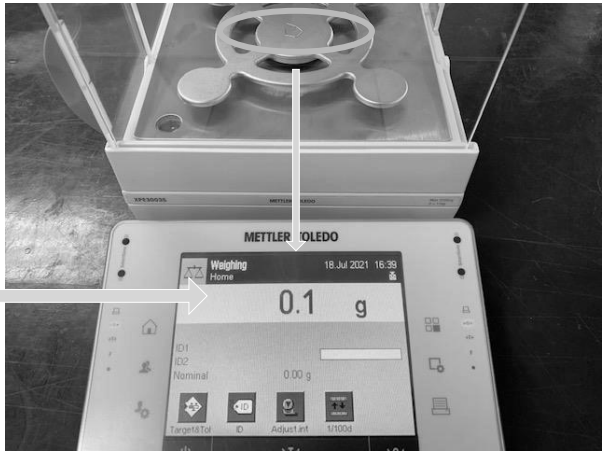
Rounding Error

ถ้าวางน้ำหนักจริง = 0.05 g

Ex เครื่องชั่งอ่านละเอียด 0.1 g

$$\% \text{ Rel. error} = \frac{error}{sample\ weight} \times 100$$

$$\% \text{ Rel. Error} = \frac{0.1g - 0.05g}{0.05g} \times 100$$



เครื่องชั่งจะอ่านได้ = 0.1 g

% Rel. Error = 100%

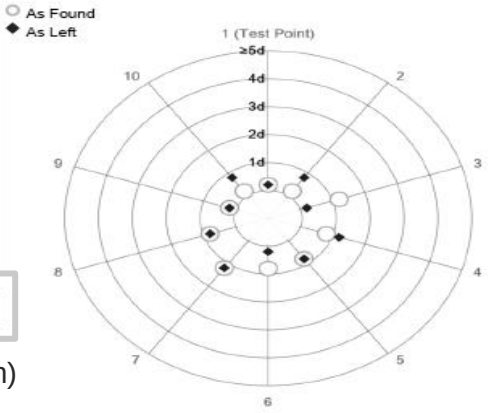
Accuracy Calibration Certificate page 2 of 5

Measurement Results

Repeatability

Test Load: 100 g

	As Found	As Left
1	99.9994 g	100.0000 g
2	99.9994 g	99.9999 g
3	99.9993 g	100.0000 g
4	99.9995 g	100.0001 g
5	99.9995 g	99.9999 g
6	99.9995 g	100.0000 g
7	99.9993 g	100.0001 g
8	99.9995 g	99.9999 g
9	99.9994 g	100.0000 g
10	99.9994 g	99.9999 g
Standard Deviation	0.00008 g	0.00008 g



The "d" in the graph represents the readability of the range/interval in which the test was performed.

The results of this graph are based upon the absolute values of the differences from the mean value.

A test load of about 50% of max capacity to max capacity

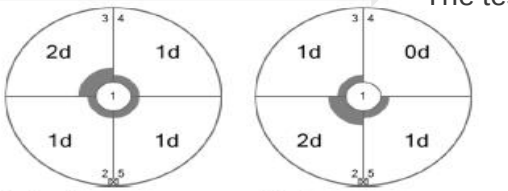
$$S = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(I_i - \bar{I})^2}$$

3 S Repeatability (standard deviation)

Eccentricity

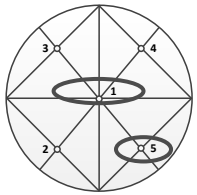
Test Load: 100 g

Position	As Found	As Left
1	99.9992 g	100.0000 g
2	99.9993 g	100.0002 g
3	99.9994 g	100.0001 g
4	99.9993 g	100.0000 g
5	99.9993 g	100.0001 g
Maximum Deviation	0.0002 g	0.0002 g



The "d" in the graph represents the readability of the range/interval in which the test was performed.

The test load should be about 1/3 of max capacity



4 $u(\delta I_{ecc})$ Eccentricity (off-centre position)

$$\Delta I_{ecc} = I_{Li} - I_{L1}$$

Accuracy Calibration Certificate Page 3 of 5

Test for errors of indication

This test requires at least five test points, distributed fairly evenly over the weighing range of the instrument

Error of Indication

As Found

	Reference Value	Indication	Error of Indication	Expanded Uncertainty	k
1	0.0000 g	0.0000 g	0.0000 g	0.17 mg	2
2	0.5000 g	0.5000 g	0.0000 g	0.18 mg	2
3	1.0000 g	1.0000 g	0.0000 g	0.18 mg	2
4	2.0000 g	2.0000 g	0.0000 g	0.18 mg	2
5	5.0000 g	5.0000 g	0.0000 g	0.18 mg	2
6	10.0000 g	10.0001 g	0.0001 g	0.19 mg	2
7	20.0000 g	19.9998 g	-0.0002 g	0.20 mg	2
8	50.0000 g	49.9997 g	-0.0003 g	0.22 mg	2
9	100.0000 g	99.9994 g	-0.0006 g	0.28 mg	2
10	150.0000 g	149.9993 g	-0.0007 g	0.39 mg	2
11	200.0001 g	199.9991 g	-0.0010 g	0.45 mg	2

As Left

	Reference Value	Indication	Error of Indication	Expanded Uncertainty	k
1	0.0000 g	0.0000 g	0.0000 g	0.17 mg	2
2	0.5000 g	0.5000 g	0.0000 g	0.18 mg	2
3	1.0000 g	1.0000 g	0.0000 g	0.18 mg	2
4	2.0000 g	2.0000 g	0.0000 g	0.18 mg	2
5	5.0000 g	5.0000 g	0.0000 g	0.18 mg	2
6	10.0000 g	10.0001 g	0.0001 g	0.19 mg	2
7	20.0000 g	20.0001 g	0.0001 g	0.20 mg	2
8	50.0000 g	49.9999 g	-0.0001 g	0.22 mg	2
9	100.0000 g	100.0000 g	0.0000 g	0.28 mg	2
10	150.0000 g	150.0001 g	0.0001 g	0.39 mg	2
11	200.0001 g	200.0001 g	0.0000 g	0.45 mg	2

0% of max capacity

25% of max capacity

50% of max capacity

75% of max capacity

100% of max capacity

Accuracy Calibration Certificate Page 3 of 5

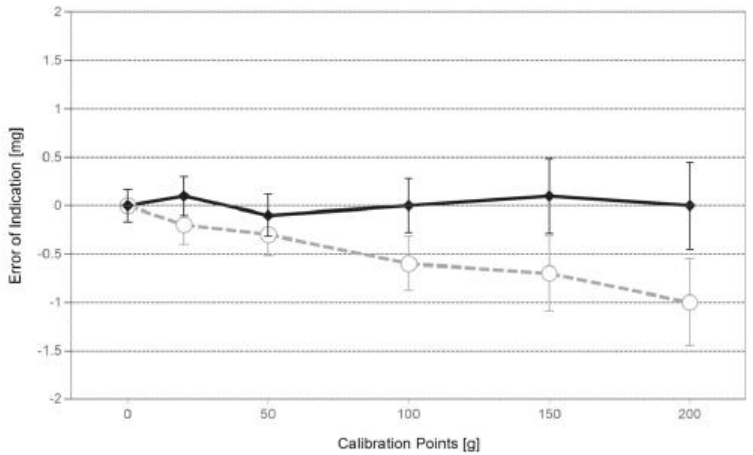
As Left

	Reference Value	Indication	Error of Indication	Expanded Uncertainty	k
1	0.0000 g	0.0000 g	0.0000 g	0.17 mg	2
2	0.5000 g	0.5000 g	0.0000 g	0.18 mg	2
3	1.0000 g	1.0000 g	0.0000 g	0.18 mg	2
4	2.0000 g	2.0000 g	0.0000 g	0.18 mg	2
5	5.0000 g	5.0000 g	0.0000 g	0.18 mg	2
6	10.0000 g	10.0001 g	0.0001 g	0.19 mg	2
7	20.0000 g	20.0001 g	0.0001 g	0.20 mg	2
8	50.0000 g	49.9999 g	-0.0001 g	0.22 mg	2
9	100.0000 g	100.0000 g	0.0000 g	0.28 mg	2
10	150.0000 g	150.0001 g	0.0001 g	0.39 mg	2
11	200.0001 g	200.0001 g	0.0000 g	0.45 mg	2

Calculation Error of Indication

$E = I - m_{ref}$

m_{ref} usually is either the nominal mass or the conventional mass



As Found

As Left

For improved legibility of the graphics only increasing measurement points are shown and measurement points close to zero are not displayed.

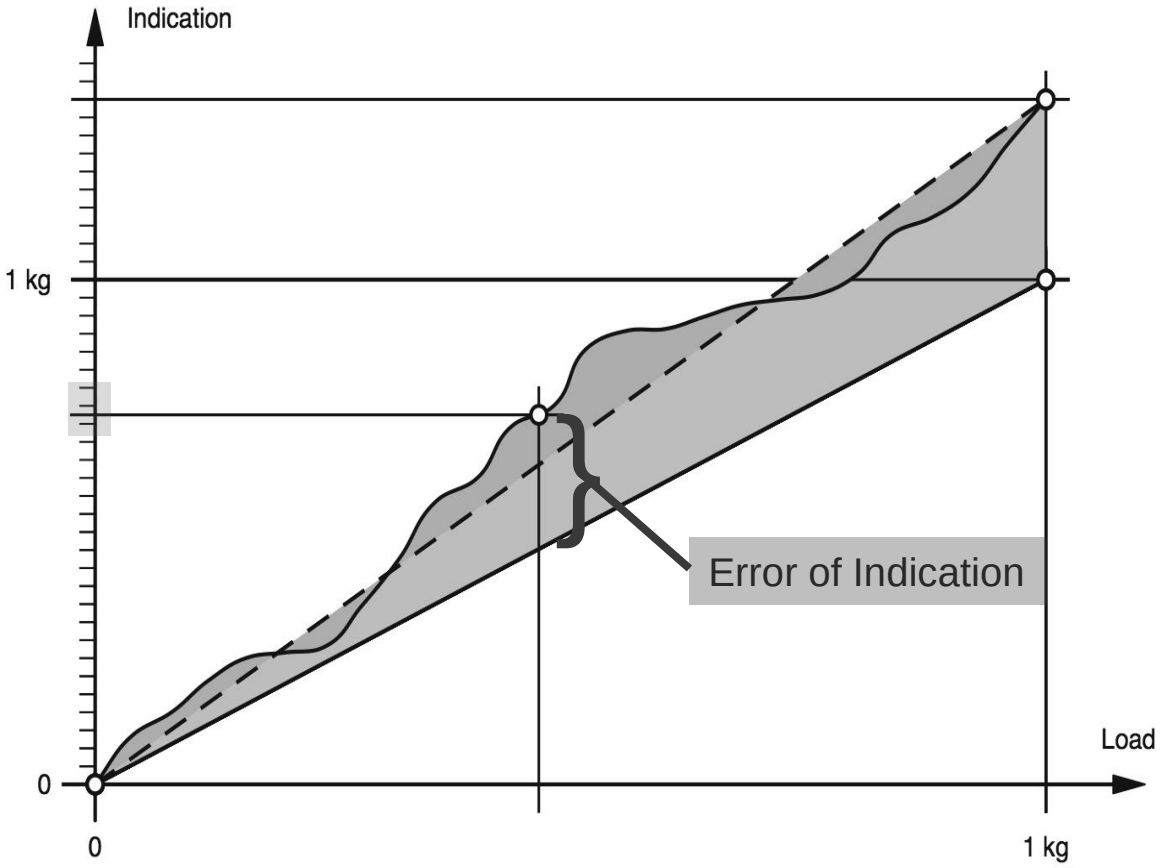
Nonlinearity (NL)

Nonlinearity

As Left

	Reference Value	Indication	Error of Indication	Expanded Uncertainty	k
1	0.0000 g	0.0000 g	0.0000 g	0.17 mg	2
2	0.5000 g	0.5000 g	0.0000 g	0.18 mg	2
3	1.0000 g	1.0000 g	0.0000 g	0.18 mg	2
4	2.0000 g	2.0000 g	0.0000 g	0.18 mg	2
5	5.0000 g	5.0000 g	0.0000 g	0.18 mg	2
6	10.0000 g	10.0001 g	0.0001 g	0.19 mg	2
7	20.0000 g	20.0001 g	0.0001 g	0.20 mg	2
8	50.0000 g	49.9999 g	-0.0001 g	0.22 mg	2
9	100.0000 g	100.0000 g	0.0000 g	0.28 mg	2
10	150.0000 g	150.0001 g	0.0001 g	0.39 mg	2
11	200.0001 g	200.0001 g	0.0000 g	0.45 mg	2

Nonlinearity (NL)



Accuracy Calibration Certificate page 4 of 5

5-8

FROM WEIGHTS

Calibration Certificate ID
TH2020-032-061421-ACC-TH

METTLER TOLEDO Service

Test Equipment

All weights used for metrological testing are traceable to national or international standards. The weights were calibrated and certified by an accredited calibration laboratory.

Weight Set 1: OIML E2

Weight Set No.:	WS44	Date of Issue:	27-Aug-2020
Certificate Number:	169098	Calibration Due Date:	26-Feb-2022

Thermo Hygrometer

Equipment No.:	IN35	Date of Issue:	01-Sep-2020
Certificate Number:	20H2028	Calibration Due Date:	30-Aug-2021

Remarks

FACT adjustment functionality activated

Equipment condition: Good

Next calibration according to customer's procedure

End of Accredited Section

The information below and any attachments to this calibration certificate are not part of the accredited calibration.

Uncertainty from weights 1 of 4

5 $u(\delta m_c)$ Weight uncertainty (alternatively: max. permissible error)

Results

Description	Density [kg/m³] ±	Deviation	Conventional Mass	Uncertainty	Tolerance OIML E2 ± mg	In Tol?
1 mg	8000 30	+0.00186 mg	1.00186 mg	0.00094 mg	0.006	yes
2 mg	8000 30	+0.00187 mg	2.00187 mg	0.00094 mg	0.006	yes
2 mg ¬	8000 30	+0.00083 mg	2.00083 mg	0.00094 mg	0.006	yes
5 mg	8000 30	+0.00254 mg	5.00254 mg	0.00094 mg	0.006	yes
10 mg	8000 30	+0.00390 mg	10.00390 mg	0.00094 mg	0.008	yes
20 mg	8000 30	+0.0032 mg	20.0032 mg	0.0012 mg	0.010	yes
20 mg ¬	8000 30	+0.0045 mg	20.0045 mg	0.0012 mg	0.010	yes
50 mg	8000 30	+0.0064 mg	50.0064 mg	0.0013 mg	0.012	yes
100 mg	8000 30	+0.0033 mg	100.0033 mg	0.0016 mg	0.016	yes
200 mg	8000 30	+0.0086 mg	200.0086 mg	0.0021 mg	0.020	yes
200 mg ¬	8000 30	+0.0094 mg	200.0094 mg	0.0021 mg	0.020	yes
500 mg	8000 30	+0.0016 mg	500.0016 mg	0.0026 mg	0.025	yes
1 g	8000 30	+0.0126 mg	1.0000126 g	0.0031 mg	0.030	yes
2 g	8000 30	+0.0144 mg	2.0000144 g	0.0041 mg	0.040	yes
2 g •	8000 30	+0.0181 mg	2.0000181 g	0.0041 mg	0.040	yes
5 g	8000 30	+0.0188 mg	5.0000188 g	0.0051 mg	0.05	yes
10 g	8000 30	+0.0210 mg	10.0000210 g	0.0063 mg	0.06	yes
20 g	8000 30	-0.0068 mg	19.9999932 g	0.0082 mg	0.08	yes
20 g •	8000 30	+0.0089 mg	20.0000089 g	0.0095 mg	0.08	yes
50 g	8000 30	-0.018 mg	49.999982 g	0.011 mg	0.10	yes
100 g	8000 30	-0.007 mg	99.999993 g	0.016 mg	0.16	yes
200 g	8000 30	+0.107 mg	200.000107 g	0.035 mg	0.30	yes
200 g •	8000 30	+0.129 mg	200.000129 g	0.035 mg	0.30	yes

Uncertainty from weights 2 of 4

6 $u(\delta m_B)$ Uncertainty due to air buoyancy

Laboratory at 77 Floor

Laboratory at 7 Floor

Uncertainty from weights 3 of 4

7 $u(\delta m_D)$ Uncertainty due to drift of weight value over time

Result

Description	Deviation (mg)	Conventional Mass	Uncertainty (mg)	Tolerance OIML E2 ± (mg)	In Tol?
1 mg	+0.00204	1.00204 mg			
2 mg	+0.00153	2.00153 mg	0.00094	0.006	yes
2 mg ¬	+0.00004	2.00004 mg	0.00094	0.006	yes
5 mg	+0.00254	5.00254 mg	0.00094	0.006	yes
10 mg	+0.00310	10.00310 mg	0.00094	0.008	yes
20 mg	+0.0029	20.0029 mg	0.0012	0.010	yes

Old Calibration Certificate

Results

Description	Density [kg/m³] ±	Deviation	Conventional Mass	Uncertainty	Tolerance OIML E2 ± mg	In Tol?
1 mg	8000 30	+0.00186 mg	1.00186 mg			
2 mg	8000 30	+0.00187 mg	2.00187 mg	0.00094 mg	0.006	yes
2 mg ¬	8000 30	+0.00083 mg	2.00083 mg	0.00094 mg	0.006	yes
5 mg	8000 30	+0.00254 mg	5.00254 mg	0.00094 mg	0.006	yes
10 mg	8000 30	+0.00390 mg	10.00390 mg	0.00094 mg	0.008	yes
20 mg	8000 30	+0.0032 mg	20.0032 mg	0.0012 mg	0.010	yes

New Calibration Certificate

Uncertainty from weights 4 of 4

8

$u(\delta m_{conv})$ Uncertainty due to convection

Store weights close to the balance, to ensure both balance and weights is the same ambient temperature

Accuracy Calibration Certificate

Expanded Uncertainty, U(E)

the expanded uncertainty of measurement has a coverage probability of 95.45 %.

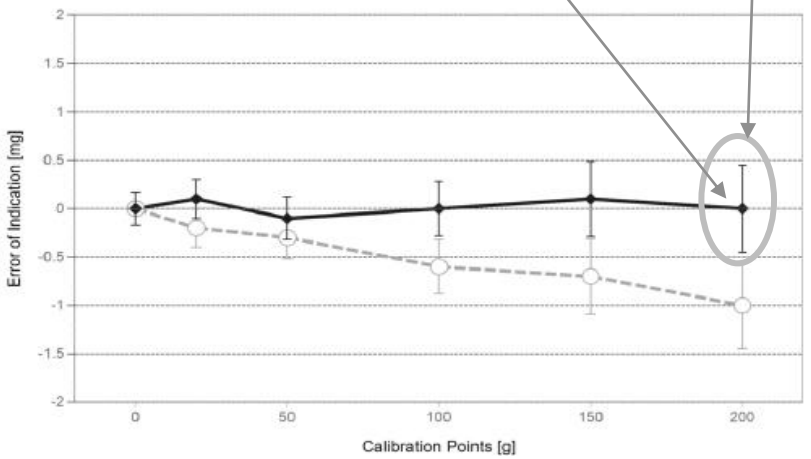
$$U(E) = k \times u(E)$$

$$u^2(E) = u^2(\delta I_{\mathrm{dig0}}) + u^2(\delta I_{\mathrm{digL}}) + u^2(\delta I_{\mathrm{rep}}) + u^2(\delta I_{\mathrm{ecc}}) + u^2(\delta m_{\mathrm{c}}) + u^2(\delta \mathrm{m_B}) + u^2(\delta m_{\mathrm{D}}) + u^2(\delta m_{\mathrm{conv}})$$

Accuracy Calibration Certificate

As Left

	Reference Value	Indication	Error of Indication	Expanded Uncertainty	k
1	0.0000 g	0.0000 g	0.0000 g	0.17 mg	2
2	0.5000 g	0.5000 g	0.0000 g	0.18 mg	2
3	1.0000 g	1.0000 g	0.0000 g	0.18 mg	2
4	2.0000 g	2.0000 g	0.0000 g	0.18 mg	2
5	5.0000 g	5.0000 g	0.0000 g	0.18 mg	2
6	10.0000 g	10.0001 g	0.0001 g	0.19 mg	2
7	20.0000 g	20.0001 g	0.0001 g	0.20 mg	2
8	50.0000 g	49.9999 g	-0.0001 g	0.22 mg	2
9	100.0000 g	100.0000 g	0.0000 g	0.28 mg	2
10	150.0000 g	150.0001 g	0.0001 g	0.39 mg	2
11	200.0001 g	200.0001 g	0.0000 g	0.45 mg	2



As Found

As Left

For improved legibility of the graphics only increasing measurement points are shown and measurement points close to zero are not displayed.

$U(E) = k * u(E)$

The true value (which is unknown) shall be with a probability of 95% within ± U around the measured value

Evaluation of Balance

Base on ILAC-G8:03/2009

As Left

	Reference Value	Indication	Error of Indication	Expanded Uncertainty	|Error|+Uncert	Tolerance	Verify
1	0.0000 g	0.0000 g	0.0000 g	0.17 mg	0.17mg	0.3mg	Pass
2	0.5000 g	0.5000 g	0.0000 g	0.18 mg	0.18mg	0.3mg	Pass
3	1.0000 g	1.0000 g	0.0000 g	0.18 mg	0.18mg	0.3mg	Pass
4	2.0000 g	2.0000 g	0.0000 g	0.18 mg	0.18mg	0.3mg	Pass
5	5.0000 g	5.0000 g	0.0000 g	0.18 mg	0.18mg	0.3mg	Pass
6	10.0000 g	10.0001 g	0.0001 g	0.19 mg	0.18mg	0.3mg	Pass
7	20.0000 g	20.0001 g	0.0001 g	0.20 mg	0.30mg	0.5mg	Pass
8	50.0000 g	49.9999 g	-0.0001 g	0.22 mg	0.32mg	0.5mg	Pass
9	100.0000 g	100.0000 g	0.0000 g	0.28 mg	0.28mg	0.5mg	Pass
10	150.0000 g	150.0001 g	0.0001 g	0.39 mg	0.49mg	0.7mg	Pass
11	200.0001 g	200.0001 g	0.0000 g	0.45 mg	0.45mg	0.7mg	Pass

Accuracy Calibration Certificate 5 of 5

Calibration Certificate ID
TH2020-032-061421-ACC-TH

METTLER TOLEDO Service

Measurement Uncertainty of the Weighing Instrument in Use

Stated is the expanded uncertainty with k=2 in use. The formula shall be used for the estimation of the uncertainty under consideration of the errors of indication. The value R represents the net load indication in the unit of measure of the device.

Temperature coefficient for the evaluation of the measurement uncertainty in use: $1.5 \cdot 10^{-6}$ / K

Temperature range on site for the evaluation of the measurement uncertainty in use: 3 K

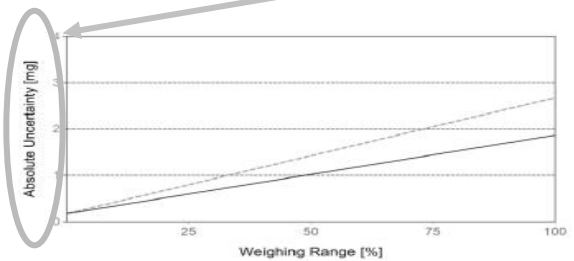
Linearization of Uncertainty Equation

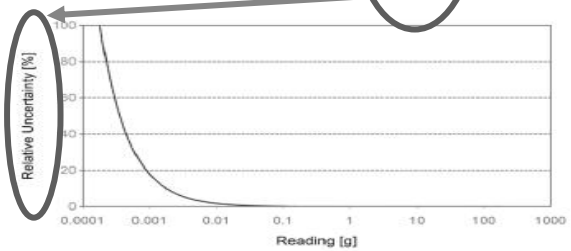
	Range		As Found	As Left
	d	Max		
1	0.0001 g	220 g	U_1 = 0.18 mg + 0.0114 mg/g · R	U_1 = 0.18 mg + 0.00769 mg/g · R

To optimize the stability of the linearization, besides of the zero load only increasing measurement points with a test load of 5% of the measurement range or larger are taken for the calculation of the linear equation.

Absolute and Relative Measurement Uncertainty in Use for Various Net Indications (Examples)

Net Indication	As Found		As Left	
0.0220 g	0.18 mg	0.82%	0.18 mg	0.82%
0.2200 g	0.18 mg	0.083%	0.18 mg	0.083%
2.2000 g	0.21 mg	0.0093%	0.20 mg	0.0090%
22.0000 g	0.43 mg	0.0020%	0.35 mg	0.0016%
220.0000 g	2.7 mg	0.0012%	1.9 mg	0.00085%





As Found

As Left

Uncertainty in Use (Unc. of a Weighing Result)

$$u^2(W) = \frac{d_0^2}{12} + \frac{d_L^2}{12} + s^2(R) + u_{rel}^2(\delta R_{ecc})R^2 + u^2(E) + \left[u_{rel}^2(\delta R_{temp}) + u_{rel}^2(\delta R_{buoy}) + u_{rel}^2(\delta R_{tare}) + u_{rel}^2(\delta R_{time})\right]R^2$$

$d_0^2/12$	Rounding error at zero
$d_l^2/12$	Rounding error at load
$s^2(R)$	Repeatability (standard deviation)
$u_{rel}^2(\delta R_{ecc})$	Eccentricity (off-center position)
$u^2(E)$	Uncertainty of the error
$u_{rel}^2(\delta R_{temp})$	Variation of temperature (change of characteristic)
$u_{rel}^2(\delta R_{buoy})$	Variation of air density
$u_{rel}^2(\delta R_{tare})$	Tare function (nonlinearity of instrument)
$u_{rel}^2(\delta R_{time})$	Creep and hysteresis

The uncertainty in use is outside the scope of an accreditation as it is interpretation, however extremely useful for the user!

ACC Certificate

ACC Certificate

Core

Calibration Certificate ID
TH2020-009-090320-ACC-TH

METTLER TOLEDO

Mettler-Toledo (Thailand) Limited
272 Soi. Soonvijai 4, Bangkapi
Huaykwang, Bangkok 10310
THAILAND
www.mt.com

NSC-TISI-TIS 17025
CALIBRATION 0062

Accuracy Calibration Certificate

Customer

Company:
Address:
City: Contact:
Zip / Postal:
State / Province: Chachoengsao
Order Number:

Weighing Device

Manufacturer:	Mettler Toledo	Instrument Type:	Weighing Instrument
Model:	MS204S/01	Asset Number:	E-B008
Serial No.:	B016027024	Terminal Model:	N/A
Building:	N/A	Terminal Serial No.:	N/A
Floor:	1	Terminal Asset No.:	N/A
Room:	Oven Room		

Range	Max. Capacity	Readability (d)
1	220 g	0.0001 g

Procedure

Calibration Guideline: EURAMET cg-18 v. 4.0 (11/2015)
METTLER TOLEDO Work Instruction: CP/W003/16

This calibration certificate contains measurements for As Found and As Left calibrations.

The sensitivity/span of the weighing instrument was adjusted before As Found and As Left calibrations with a built-in weight.

	Temperature		Humidity	
As Found	Start: 22.7 °C	End: 22.9 °C	Start: 46.7 %	End: 42.4 %
As Left	Start: 22.9 °C	End: 22.9 °C	Start: 40.5 %	End: 40.4 %

As Found Calibration Date: 03-Sep-2020
As Left Calibration Date: 03-Sep-2020
Issue Date:

Calibrator:
Kassakorn Tassanachaisakul
Approved Signatory:

Annex

Attachment to Calibration Certificate
TH2042-051-0T1A1T-ACC-TH
GWP® Certificate

METTLER TOLEDO Service

GWP® Certificate

As Found ✓ The weighing device meets the process requirements.

As Left ✓ The weighing device meets the process requirements.

Tests Performed: ☑ As Found ☐ As Left ☑ As adjustments/modifications were made, As Left results correspond to As Found.

Process Requirements

Weighing Tolerance: 1% | Smallest Net Weight: 1.0000 g | Safety Factor: 2

Safe Weighing Range

While the value in the graph matches the actual calibration results, the measurement uncertainty curve is only a visual representation. The graph reflects As Left testing, which is only As Found was performed.

Software Version: 1.1.12.579
Report Version: 7.0
Form Number: F1502

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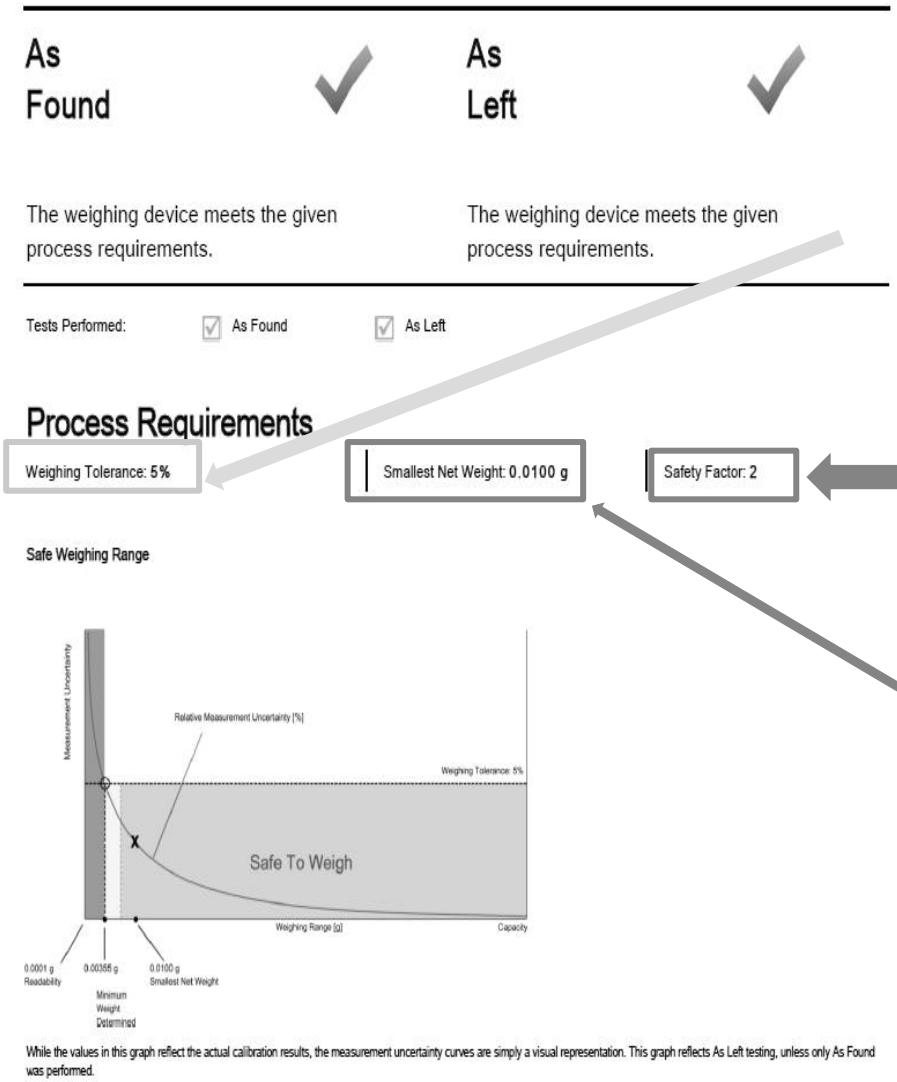
Page 1 of 4

Evaluation of Balance

GWP Certificate page 1 of 4



As Found ✓

The weighing device meets the given process requirements.

As Left ✓

The weighing device meets the given process requirements.

Tests Performed: ☑ As Found ☑ As Left

Process Requirements

Weighing Tolerance: 5%

Smallest Net Weight: 0.0100 g

Safety Factor: 2

Safe Weighing Range

While the values in this graph reflect the actual calibration results, the measurement uncertainty curves are simply a visual representation. This graph reflects As Left testing, unless only As Found was performed.

Weighing Tolerance

- % ความผิดพลาดที่ยอมรับได้ของ User
- 0.10% จะใช้กับอุตสาหกรรมยา (USP41)
- 1% จะใช้กับอุตสาหกรรมอาหารและเคมี

Smallest Net Weight

- น้ำหนักต่ำสุดที่ User ใช้งาน

Set up Tolerance of weighing

1. How amount of weight you want to measure?

   0.01 g

2. How much of error you accept?

   $\pm$ 0.0005 g

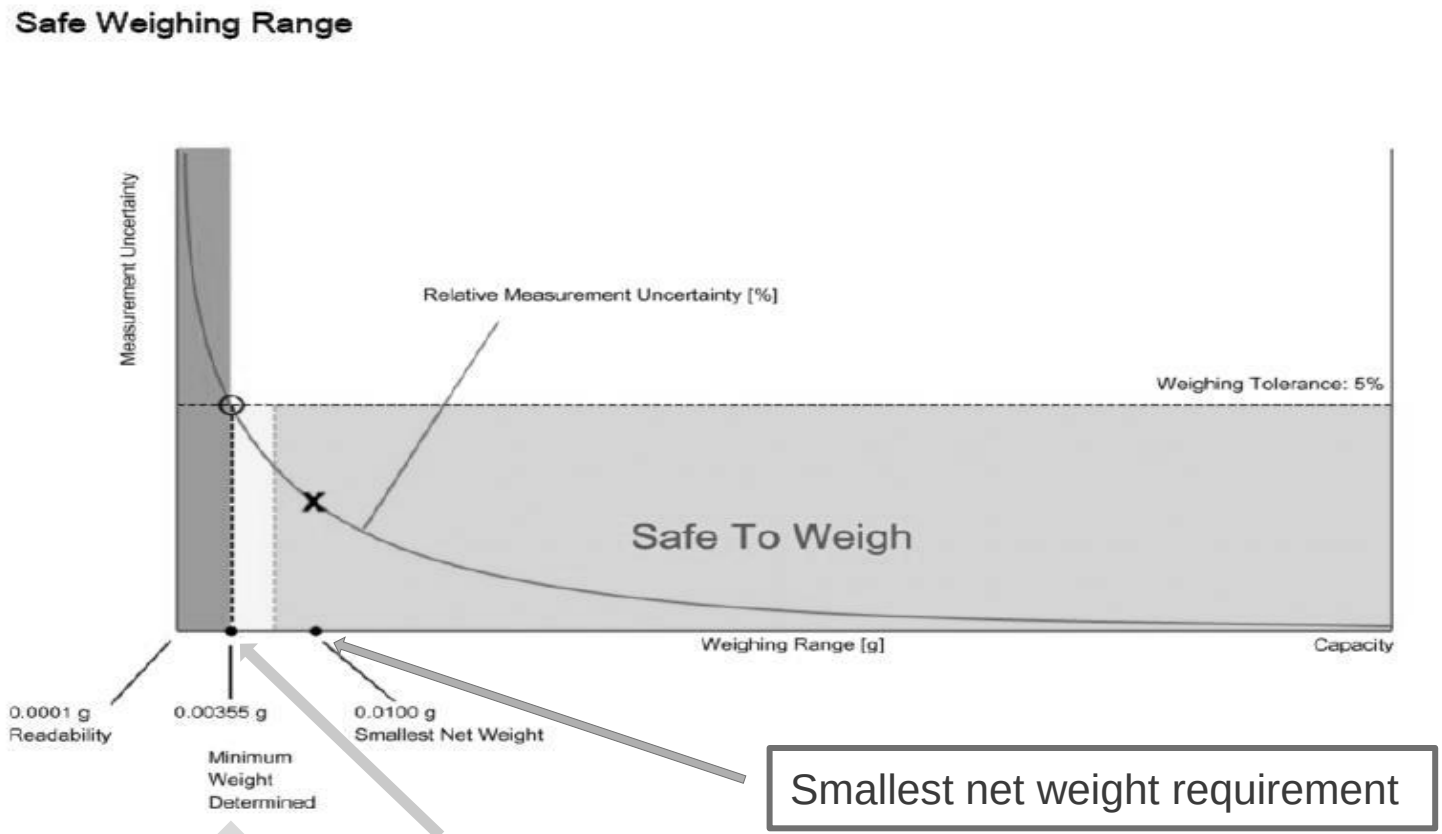
3. Calculate relative error and % Rel. error?

$$\% \text{ Rel. error} = \frac{error}{sample\ weight} \times 100$$

$$\% \text{ Rel. error} = \frac{0.0005g}{0.01g} \times 100$$

$$= 5\%$$

GWP Certificate page 1 of 4



Minimum Weight

As Found Minimum Weight Table

Minimum weights for different weighing tolerances and safety factors					
	Safety Factor				
Tolerance	1	2	3	5	10
0.1%	0.17968 g	0.36354 g	0.55172 g	0.94169 g	2.00410 g
0.2%	0.08933 g	0.17968 g	0.27108 g	0.45708 g	0.94169 g
0.5%	0.03561 g	0.07138 g	0.10731 g	0.17968 g	0.36354 g
1%	0.01778 g	0.03561 g	0.05347 g	0.08933 g	0.17968 g
2%	0.00889 g	0.01778 g	0.02669 g	0.04454 g	0.08933 g
5%	0.00355 g	0.00711 g	0.01067 g	0.01778 g	0.03561 g

✓ Pass: The determined minimum weight meets the requirement for the smallest net weight.

As Left Minimum Weight Table

Minimum weights for different weighing tolerances and safety factors					
	Safety Factor				
Tolerance	1	2	3	5	10
0.1%	0.17901 g	0.36082 g	0.54549 g	0.92369 g	1.92429 g
0.2%	0.08916 g	0.17901 g	0.26957 g	0.45280 g	0.92369 g
0.5%	0.03558 g	0.07127 g	0.10708 g	0.17901 g	0.36082 g
1%	0.01778 g	0.03558 g	0.05341 g	0.08916 g	0.17901 g
2%	0.00889 g	0.01778 g	0.02668 g	0.04450 g	0.08916 g
5%	0.00355 g	0.00711 g	0.01066 g	0.01778 g	0.03558 g

✓ Pass: The determined minimum weight meets the requirement for the smallest net weight.

As Left

$U_1 = 0.18\ mg + 0.00769\ mg/g \cdot R$

$$R_{min,SF} = \frac{\alpha_{gl} \cdot SF}{Req - \beta_{gl} \cdot SF}$$

Example;

MW= [0.00018*2] / (5%-0.00000769*2)

= 0.00036/(0.05-0.00001538)

=0.00036/0.04998462

Approx.= 0.0072g

Attachment to Calibration Certificate:
TH2020-032-061421-ACC-TH
GWP® Certificate

METTLER TOLEDO Service

Measurement Results

Results Summary

	Repeatability	Eccentricity	Error of Indication
As Found	✓	✓	✓
As Left	✓	✓	✓

✓ = Passed
✗ = Failed
⚠ = Safety Factor not met

Repeatability

Test Load: 100 g

		As Found		As Left	
Tolerance	Control Limit	Std. Deviation	Result	Std. Deviation	Result
0.1%	N/A	0.00008 g*	N/A	0.00008 g*	N/A
0.2%	N/A		N/A		N/A
0.5%	N/A		N/A		N/A
1%	0.00005 g		✗		✗
2%	0.00010 g		✓		⚠
5%	0.00025 g		✓		✓

*The calculated standard deviation value is below the rounding error of the balance. The 0.41*d rule is used for the assessment of this repeatability test and the calculation of the minimum weight.

The weighing tolerance is met if the standard deviation is less than or equal to the corresponding control limit.

(control limit = weighing tolerance * smallest net weight / k)

GWP Certificate page 3 of 4

Eccentricity

Test Load: 100 g

		As Found		As Left	
Tolerance	Control Limit	Deviation	Result	Deviation	Result
0.1%	0.0500 g	0.0002 g	✓	0.0002 g	✓
0.2%	0.1000 g		✓		✓
0.5%	0.2500 g		✓		✓
1%	0.5000 g		✓		✓
2%	1.0000 g		✓		✓
5%	2.5000 g		✓		✓

The weighing tolerance is met if the deviation is less than or equal to the corresponding control limit.

(control limit = test weight * weighing tolerance / 2)

Error of Indication

As Found

		Control limits for various weighing tolerances					
Reference Value	Error	0.1%	0.2%	0.5%	1%	2%	5%
0.0000 g	0.0000 g	N/A	N/A	N/A	N/A	N/A	N/A
20.0000 g	-0.0002 g	0.0100 g	0.0200 g	0.0500 g	0.1000 g	0.2000 g	0.5000 g
50.0000 g	-0.0003 g	0.0250 g	0.0500 g	0.1250 g	0.2500 g	0.5000 g	1.2500 g
100.0000 g	-0.0006 g	0.0500 g	0.1000 g	0.2500 g	0.5000 g	1.0000 g	2.5000 g
150.0000 g	-0.0007 g	0.0750 g	0.1500 g	0.3750 g	0.7500 g	1.5000 g	3.7500 g
200.0001 g	-0.0010 g	0.1000 g	0.2000 g	0.5000 g	1.0000 g	2.0000 g	5.0000 g
Result		✓	✓	✓	✓	✓	✓

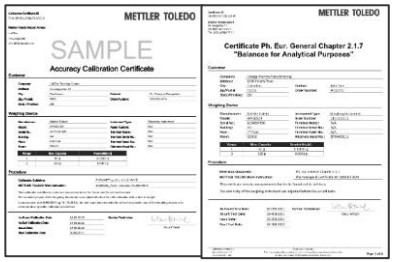
As Left

		Control limits for various weighing tolerances					
Reference Value	Error	0.1%	0.2%	0.5%	1%	2%	5%
0.0000 g	0.0000 g	N/A	N/A	N/A	N/A	N/A	N/A
20.0000 g	0.0001 g	0.0100 g	0.0200 g	0.0500 g	0.1000 g	0.2000 g	0.5000 g
50.0000 g	-0.0001 g	0.0250 g	0.0500 g	0.1250 g	0.2500 g	0.5000 g	1.2500 g
100.0000 g	0.0000 g	0.0500 g	0.1000 g	0.2500 g	0.5000 g	1.0000 g	2.5000 g
150.0000 g	0.0001 g	0.0750 g	0.1500 g	0.3750 g	0.7500 g	1.5000 g	3.7500 g
200.0001 g	0.0000 g	0.1000 g	0.2000 g	0.5000 g	1.0000 g	2.0000 g	5.0000 g
Result		✓	✓	✓	✓	✓	✓

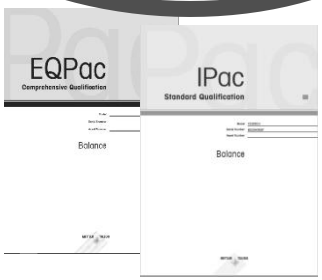
(control limit = test weight * weighing tolerance / 2)

Good Weighing Practice (GWP®)

GWP Recommendation
Selection of the right device



ACC and GWP Certificate
Device meets ACC requirements



IPac
Professional installation and configuration

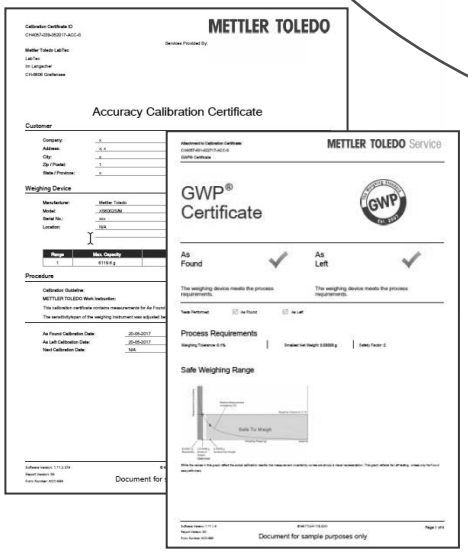
The sample that you wants to weigh

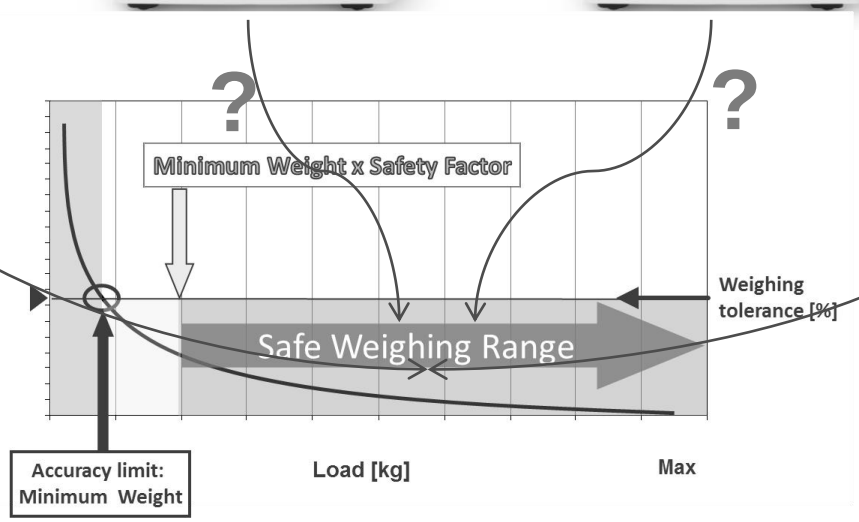
?

?

?

?





Am I in the safe Weighing Range?

Only after a calibration do we know if the weighing results are sufficiently accurate enough

Process Requirements

Weighing Tolerance: 1% | Smallest Net Weight: 10.00 g | Safety Factor: 2

1 Weighing Tolerance

- The weighing error that is acceptable, specified as ± percentage
- More Weighing Tolerance have smaller Min Weight

Tolerance	1
0.1%	0.11778 g
0.2%	0.05879 g
0.5%	0.02349 g
1%	0.01174 g
2%	0.00587 g
5%	0.00235 g

2 Smallest Net Weight

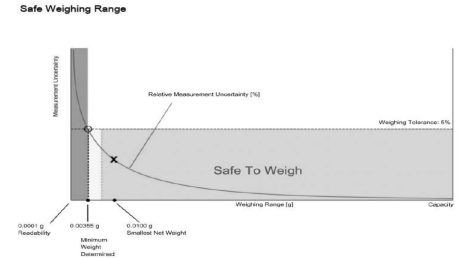
- The smallest amount of net sample mass that the user wants to weigh
- More Smallest Net Weight that more than Min Weight

GWP® Certificate

As Found ✓ As Left ✓

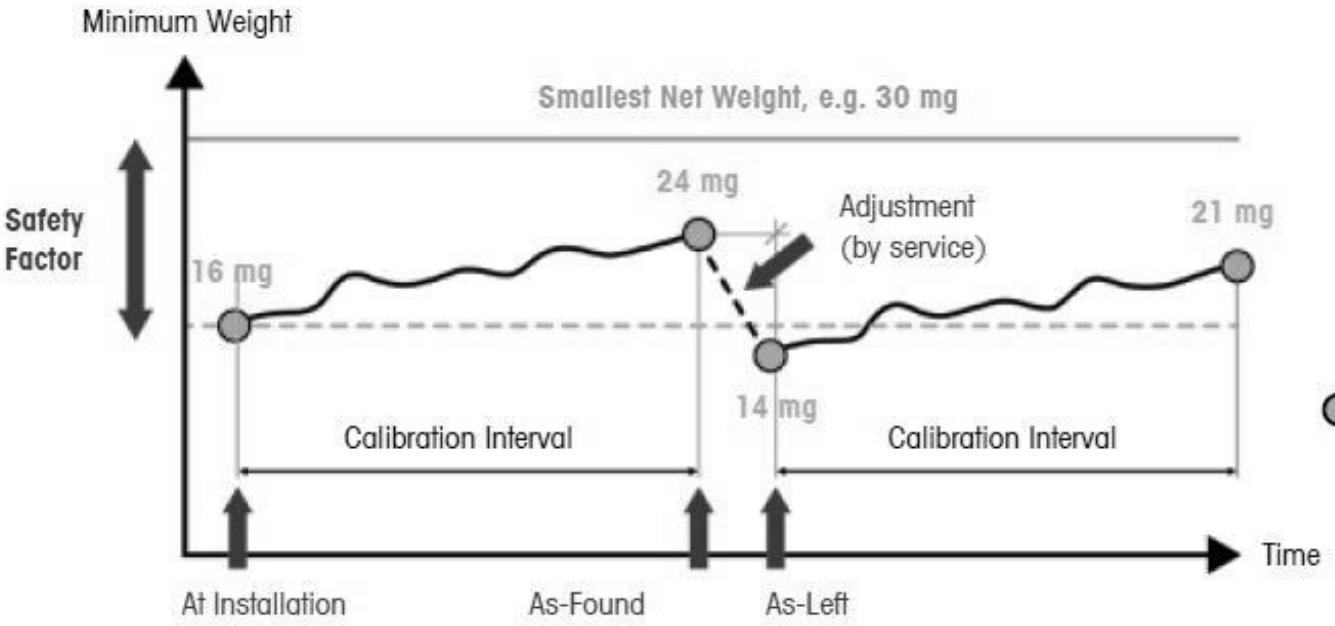
3 Safety Factor

- The performance of a balance is influenced by a variety of factors and will therefore change over time.



Variability of Minimum Weight – Safety Factor

- Consideration of a Safety Factor:
  - The performance of a balance is influenced by a variety of factors and will therefore change over time.



- Minimum Weight

How Would You Describe
Each of Your Weighing Processes?

Your Rating: Effects on Quality, Cost, Safety, Efficiency and Waste	Quality Impact	Process Tolerance %
Super-critical components: high effect and / or cost	Acute	≤ 0.1
Expensive, very critical, components or processes	Crucial	0.1
Key components & processes	Very High	0.2
Above average quality & critical processes	High	0.5
Average requirements & processes	Median	1
Inexpensive base materials	Low	2
Low cost materials and products with low effectivity	Negligible	5 ~10

www.mt.com/GWP

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Rule of Thumb

A Safety Factor Ensures Reliable Measurements

Your Considerations for Safe Weighing	Safety Factor
No considerations for variations in the device, operators or environment. High potential for Out of Specification (OOS) results.	1
Devices are installed in an ideal environment. Not recommended due to statistical variations. Potential for OOS results.	1.5
"Laboratory conditions", insignificant environmental influences, one or two operators.	2
"Production conditions" - accounting for one or two low-magnitude influences such as temperature variation or low-frequency vibration, several operators.	3
Increasing levels of safety consideration accounting for many low-magnitude environmental influences, several operators, heavy usage or accumulated debris, varying tare containers. Portable Scales.	4 – 10

Note: Higher-magnitude variations in environmental conditions (temperature, vibration, wind) must be eliminated. In these cases, increasing the safety factor will not bring the desired results

How Large is the Error now?

10 cm | 2

Drilling holes 12 cm apart instead of 10 cm

Serious ERROR!

Acceptable Error

1000 cm (10 m) | 2

Constructing a 10 metre fence with an error of 2 centimetres

Negligible Error

Running 2 centimetres more than 1 km

100 000 cm (1 km) | 2

Determining Error

METTLER TOLEDO

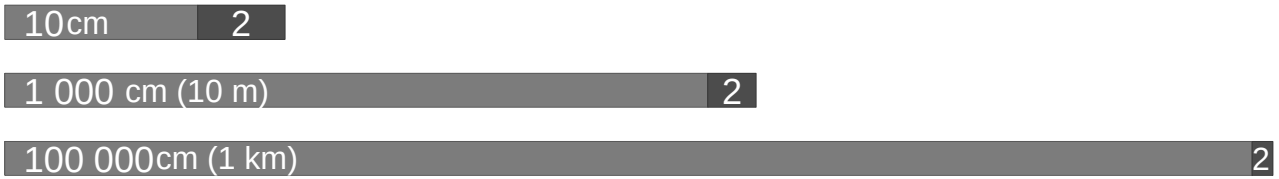
Correct value	Measured value	Absolute Error	Relative error
10	12	2	20%
1 000	1 002	2	0,2%
100 000	100 002	2	0,002%

Error = Measured – Correct value

12 – 10 = 2
1 002 – 1 000 = 2
100 002 – 100 000 = 2

Relative error = Error ÷ Correct value

2 ÷ 10 = 0,2 → 20%
2 ÷ 1 000 = 0,002 → 0,2%
2 ÷ 100 000 = 0,00002 → 0,002%

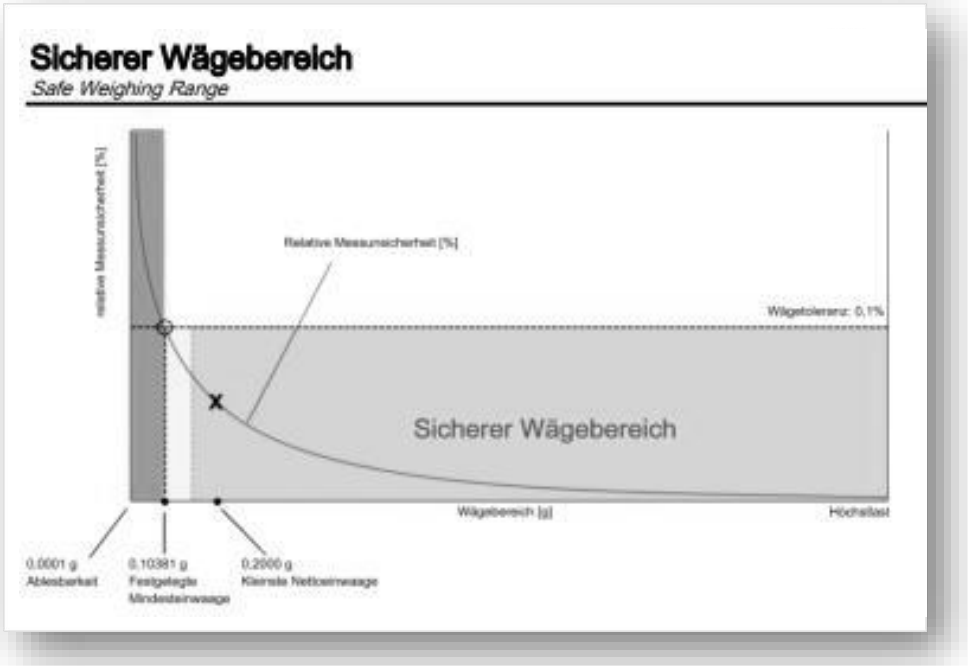


Comparing absolute and relative tolerances (same results)

Absolute value

OR

Relative value?



The worst decision of a Pass / Fail statement is if we accept (Pass) a wrong result

Measurement Uncertainty of the Weighing Instrument in Use

Stated is the expanded uncertainty with k=2 in use. The formula shall be used for the estimation of the uncertainty under consideration of the errors of indication. The value R represents the net load indication in the unit of measure of the device.

Temperature coefficient for the evaluation of the measurement uncer

Temperature range on site for the evaluation of the measurement un

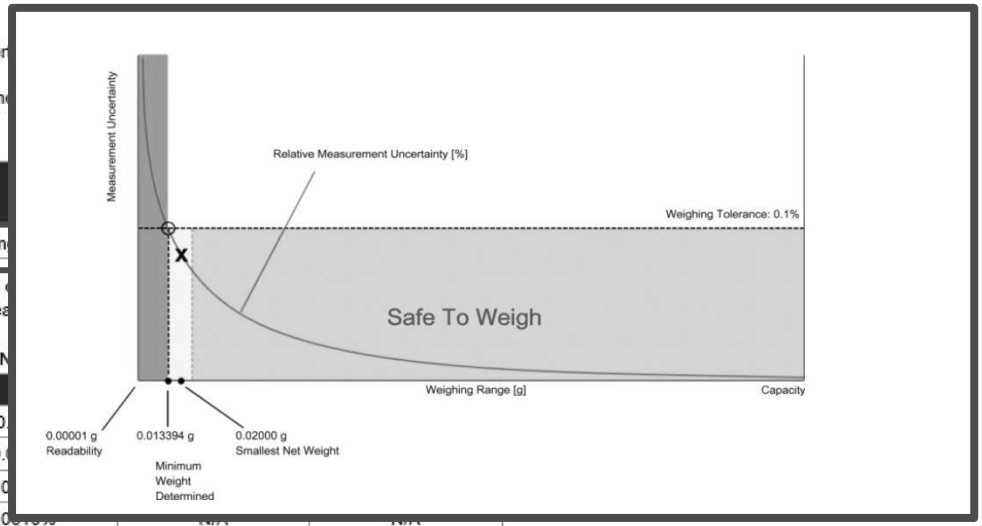
Linearization of Uncertainty Equation

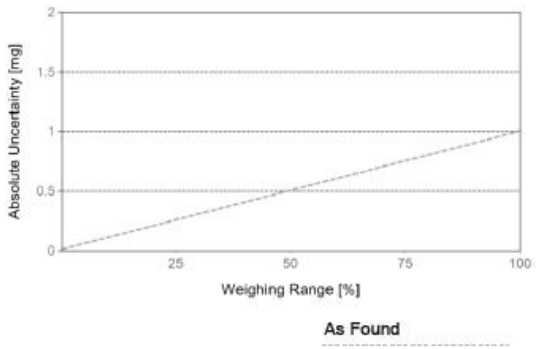
Range			As Found
	d	Max	
1	0.00001 g	220 g	U_1 = 0.013 mg + 0.00451 m

To optimize the stability of the linearization, besides of the zero load measurement range or larger are taken for the calculation of the linea

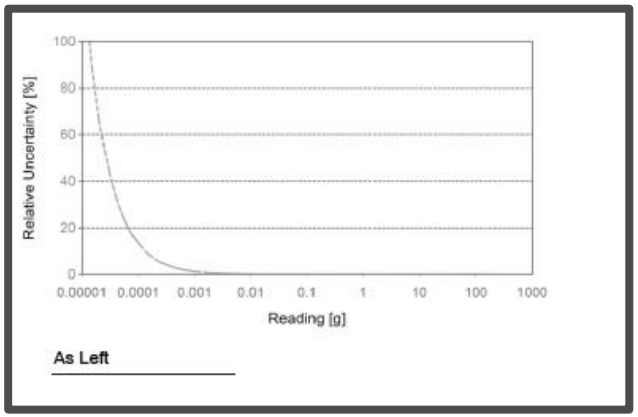
Absolute and Relative Measurement Uncertainty in Use for Various N

Net Indication	As Found			
0.00220 g	0.013 mg	0.		
0.02200 g	0.013 mg	0.		
0.22000 g	0.014 mg	0.0		
2.20000 g	0.023 mg	0.00		
220.00000 g	1.0 mg	0.00046%	N/A	N/A





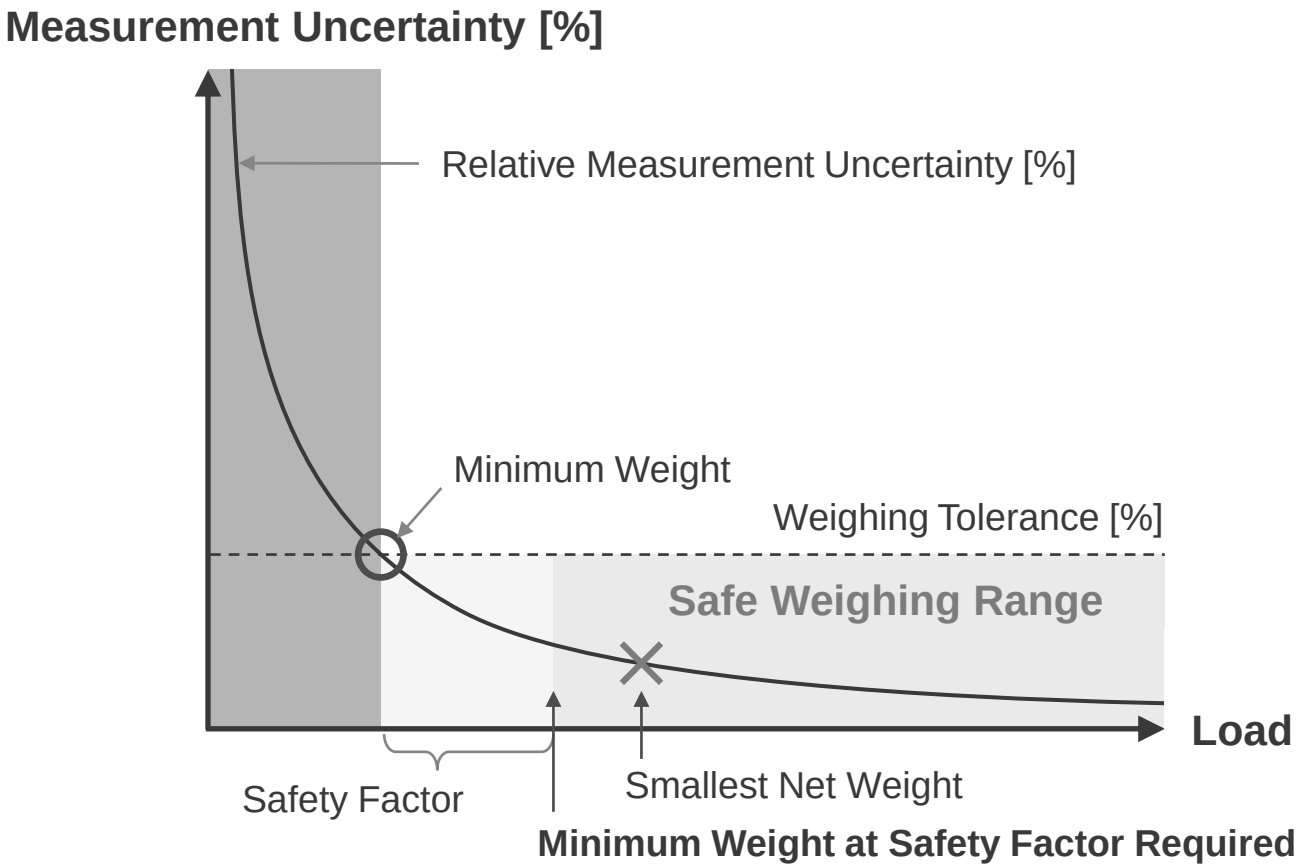
As Found



As Left

Amounts weighed in practice, i.e. Smallest-Net-Weight, (SNW) should not be less than the Minimum Weight but taking into consideration the safety factor.

Weighing below the minimum weight → Results outside Process Tolerance
Weighing above the (minimum weight x Safety Factor) → **Safe Weighing Range**

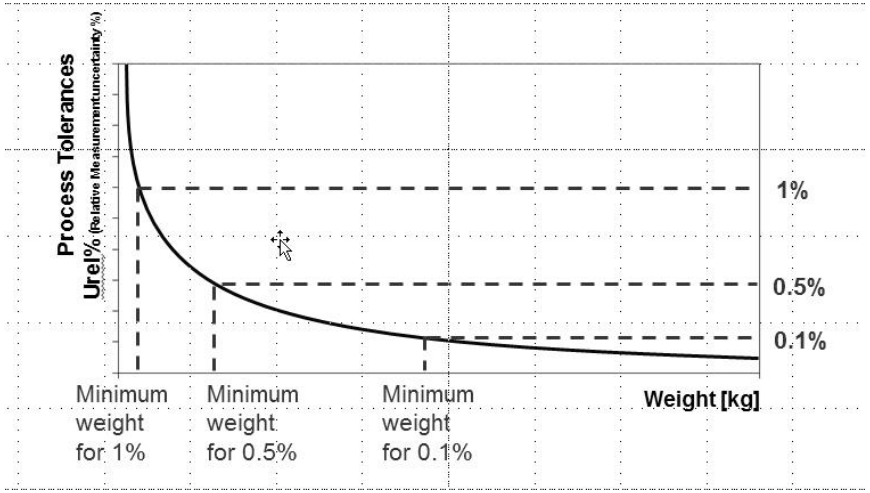


The minimum weight increases as the tolerances become more critical as shown from this extract from a calibration certificate which included this invaluable information as an annex.

Because of drift and the influence of the environment etc. it should not be assumed that the minimum weight will remain constant with time.

As Left Minimum Weight Table

Minimum weights for different weighing tolerances and safety factors	
Tolerance	1
0.02%	42.248 g
0.1%	8.220 g
0.2%	4.096 g
0.5%	1.635 g
1%	0.817 g
2%	0.408 g
5%	0.163 g



How does your device perform on-site?

Is the device fit-for-purpose?

- Use the calibration results to assess if the device performs as needed.
- Confirm sufficiently accurate weighing – the measurement uncertainty must be smaller or equal to your weighing tolerance.
- The GWP® Certificate as an annex to the ACC report **shows and document the device is fit for your purpose.**


GWP®
Certificate

As Found

As Left

Process Requirements

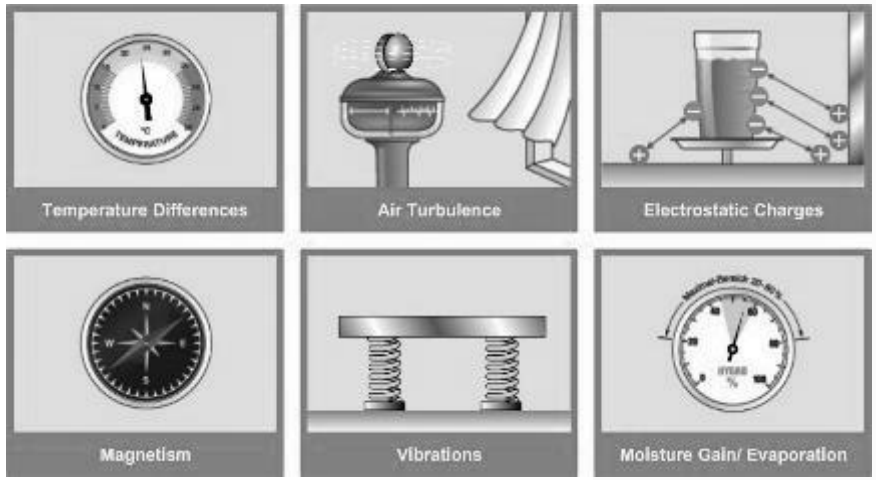
Safe Weighing Range

Document for sample purposes only

USP Chapter 1251

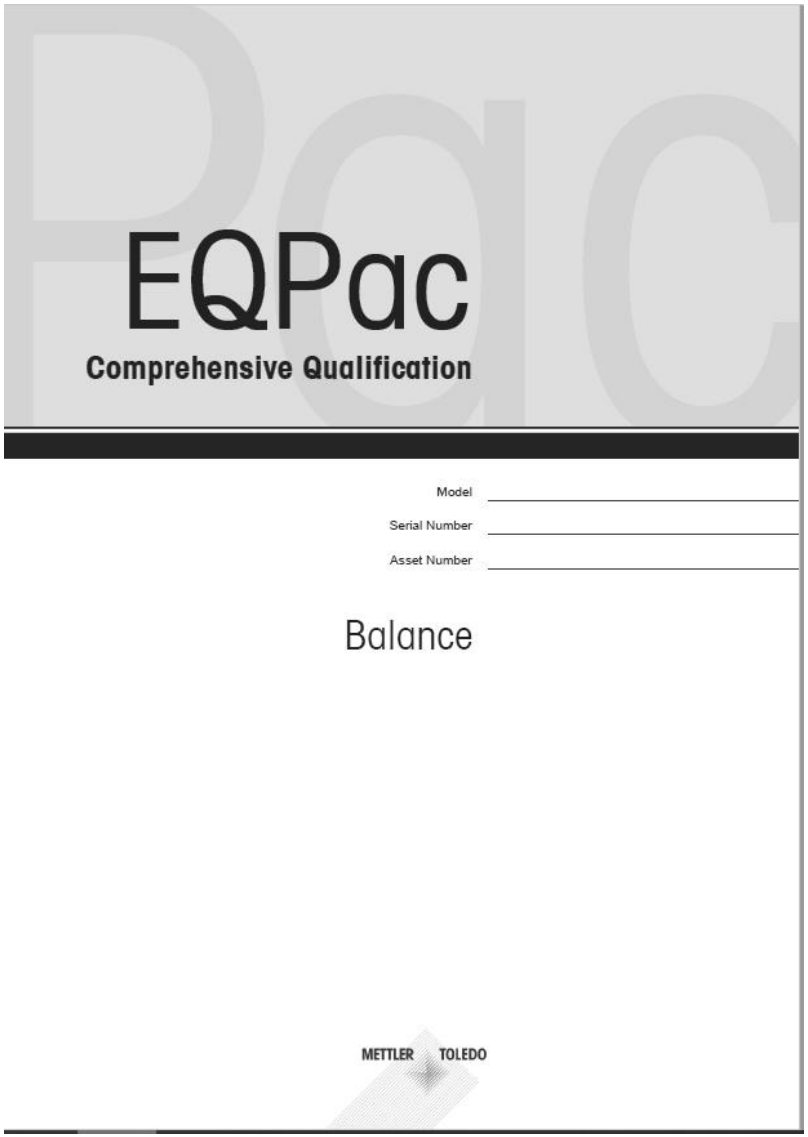
- **Balance Environment:**
  - The balance is placed in a suitable location with sufficiently low levels of vibration and air current.
  - The balance and the surrounding Over an extended period of time, balance drift and other work area have to be kept neat and tidy.
  - When a balance is moved, it must be allowed to adjust to the temperature of its new environment and be recalibrated.
- **Performance Qualification of Balances:**
  - Repeatability
  - Sensitivity
  - Eccentricity
  - Linearity
  - Use of built-in weights
- **Consideration of a Safety Factor**
- **Balance Uncertainties**
- **Weighing the Material**

Installation and Location



- Environmental parameters can have an influence on weighing:
  - Temperature and direct sunlight
  - Air currents
  - Electrostatic and magnetic forces
  - Vibrations
- Installation location should be carefully considered so as not to adversely affect balance performance:
  - Use a stable weighing bench
  - Protect against electrostatic charges
  - Minimize air currents (by instrument design)

EQPac Comprehensive Qualification



- **Audit Proof:**
  - Pass/fail statements and documentation of parameters are used to rigorously qualify the equipment at every step Sensitivity
- **Lifecycle Management Tool:**
  - Equipment details, setup, expanded function testing, performance testing and maintenance plan are thoroughly documented to prove compliance from day one.
- **Recommended for following industries:**
  - Pharma, Biotech, Cosmetics, Food, Hazardous, Medical, Chemical Ingredient Suppliers

Installation Qualification (IQ)

- The purpose of an Installation Qualification is to demonstrate installation conditions are appropriate, equipment has been received as ordered, all documentation, manufacturer certificates and drawings are available, site requirements are appropriate, and equipment can be installed and put into operation successfully.

3.1 Reason for Qualification

The installation and qualification of equipment is a/an: Qualification after a relocation of an instrument

3.2 Receiving and Unpacking

The table below details the verification of all standard items and documentation included in the packaging with the balance. The items are checked for completeness by means of the "Delivered Items List" detailed in the operating instructions. Missing items are recorded in section "Missing Items".

3.2.1 Initial Situation

The instrument was found originally packed Instrument was already installed

3.2.2 Condition of Delivery Box

The packaging of the delivered items listed above was shipped in appropriate condition and does not have signs of transport damages that could cause harm to the equipment. Pass - no damages

3.2.3 Condition of Delivered Equipment

All equipment listed above including power cable(s), external power adaptor(s), peripheral(s) or accessories are free of visible physical damage. Pass - no damages

Operational Qualification(OQ)

- The purpose of an Operational Qualification is to demonstrate that the product meets its predetermined specifications and quality attributes. The functional tests required to fulfil this purpose are listed below. Functional procedures that are not applicable for this installation are not recorded in this section.

4.3 Functional Tests

4.3.1 Display Functionality Test

Objective	Confirm the display is operating free of errors, and showing the expected functionality.	
Procedure	- Visually inspect the terminal display to ensure it is free of bubbles or micro cracks and is legible in the working environment. - Switch off power and Switch on power again. - For non-touch screen displays check if all digits and symbols are displayed properly during start-up procedure. - For touch screen displays check if entry picture is shown and check For pixel errors. - check if contrast setting of the display is appropriate.	
Acceptance Criteria	The display shows no physical damages, all segments / pixels are displayed and legibility is appropriate.	Pass

4.3.2 Touch Screen Functionality Test

Objective	Confirm the Touch Screen is operating free of errors and showing the expected functionality.	
Procedure	Activate soft keys in all 4 corners of the touch screen.	
Acceptance Criteria	The touch screen responds accordingly by activating the correct function if a soft key is pressed.	Pass

USP Chapter 41

The United States Pharmacopeia (USP) has stringent requirements for balances used for weighing analytes for quantitative measures.

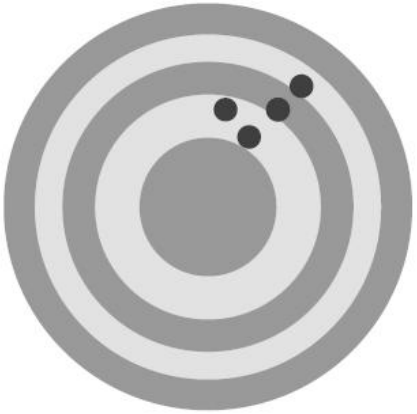
General Chapter 41 sets three distinct requirements used for materials that must be accurately weighed in order:

- Calibrated over the operating range
- Repeatability
- Accuracy

Performance Checks

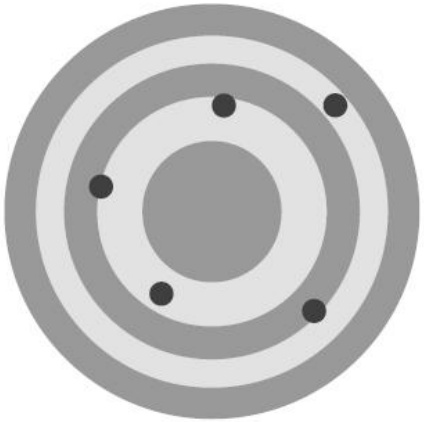
Performance checks are carried out to evaluate the random and systematic error of a balance; they consist of measuring precision and accuracy respectively and comparing the results obtained to pre-defined acceptance criteria. Balances are considered suitable if none of these errors exceeds 0.10 per cent.

1



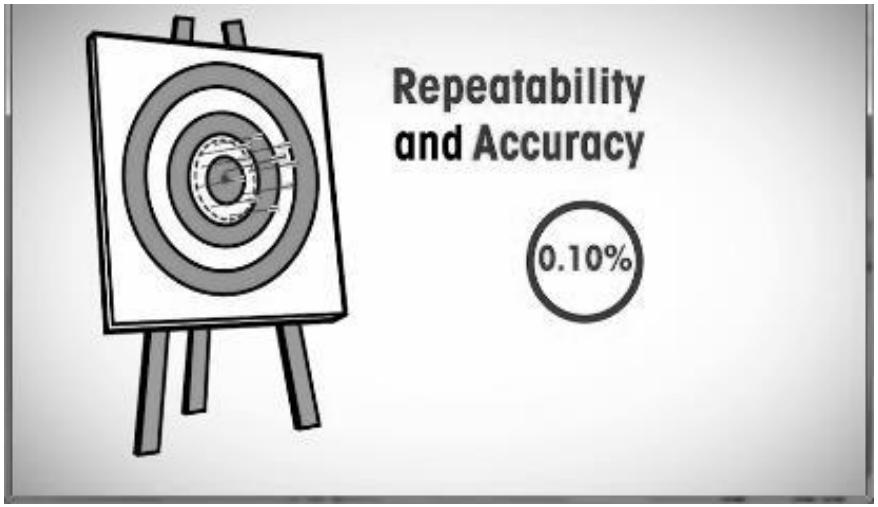
Precise, but not accurate

2



Accurate, but not precise

- The tests for **random** and **systematic** errors USP General Chapter 41 "Balances"
- The acceptance criterion tests is 0.10 %, **identical** to USP General Chapter 41



Test of Repeatability (Precision)

Use a single weight denomination preferably in the lower end of the measurement range, for example not more than 5 per cent of the maximum capacity of the balance.

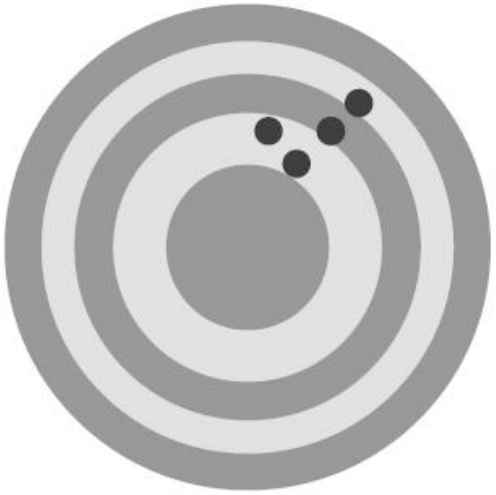
The repeatability is satisfactory, if:

$$\frac{2 \times s}{m_{snw}} \times 100 \leq 0.10$$

$$\frac{2 \times s}{m_{snw}} \times 100 \leq 0.10$$

s = standard deviation of the indicated values (e.g. in grams);

m_{snw} = smallest net weight (e.g. in grams). This value is defined by the user as the smallest net amount of substance that will be weighed on the balance.



Precise, but not accurate

- Repeatability is dominant at the lower end of the measurement range
- Therefore, a test load no more than 5 % is suggested
- E.g. a 10 g test load for a balance with a nominal capacity of 200 g
- One important user requirement is the **smallest net weight**, not to be confused with **minimum weight**

Test of Repeatability (Precision)

NOTE: if $s < 0.41 \times d$, where d is the readability (scale interval) of the balance, replace s by $0.41 \times d$;

The lower limit of "$0.41 \times d$" for the standard deviation originates from the rounding error of the balance. Given that weighing operations comprise two readings (tare and net sample weight), and as the rounding error allocated to a single reading is calculated as "$0.29 \times d$", in this case the propagation of errors by a quadratic sum gives "$0.41 \times d$".

	As Found	As Left
1	0.5000 g	N/A
2	0.5000 g	N/A
3	0.5000 g	N/A
4	0.5000 g	N/A
5	0.5000 g	N/A
6	0.5000 g	N/A
7	0.5000 g	N/A
8	0.5001 g	N/A
9	0.5000 g	N/A
10	0.5000 g	N/A

Mean Value	0.50001 g	N/A
Standard Deviation	0.00003 g	N/A
Calculation [1]	0.0164 %	N/A
Assessment [2]	0.02 % ✓	N/A
Requirement	0.10 %	N/A
Minimum Weight [3]	0.0820 g	N/A

- In this example, for an Analytical balance with a readability d = 0.1 mg, the calculated standard deviation for the as left assessment is smaller than 0.41d
- Therefore, for the assessment, the standard deviation is replaced by 0.41d = 0.000041 g

$$\frac{2 \times (0.41 \times d)}{\text{Smallest Net Weight}} = \frac{2 \times 0.000041\ \text{g}}{0.5000\ \text{g}} = 0.0002 = 0.02\% < 0.10\ \%$$

Minimum Weight

Based on the result of the repeatability test, the minimum weight (m_{min}) of the balance can be determined. The "minimum weight" is the smallest net sample mass that can be weighed on the balance, whilst continuing to comply with the repeatability test criterion. It is given by the following equation:

$$m_{min} = 2000 \times s$$

M = 2000 x 0.41(0.0001) = 0.082 g

NOTE: if $s < 0.41 \times d$, replace s by $0.41 \times d$

- The minimum weight should not be confused with the smallest net weight:
  - The **smallest net weight** is a user requirement and describes the smallest amount of net sample mass that the user wants to weigh on the balance
  - The **minimum weight** is a calculated value based on a performance test (repeatability), and describes the smallest amount of net sample mass that can still be weighed whilst complying with the acceptance criterion of 0.10 %
- As a consequence, the smallest net weight must be larger than the minimum weight
- As the balance performance is not constant over time (e.g. due to external influences), it is recommended to apply a safety factor

Test of Accuracy – Focus on Sensitivity

The sensitivity test assesses the parameter that most significantly influences the accuracy of the balance.

The sensitivity deviation increases approximately linearly with the load, and thus is more significant in the upper part of the weighing range. In addition, as the influence of the random error is dominant at the lower end of the measuring range, using a test load with a mass below 5 per cent of the capacity of the balance to determine the error of sensitivity is not meaningful.

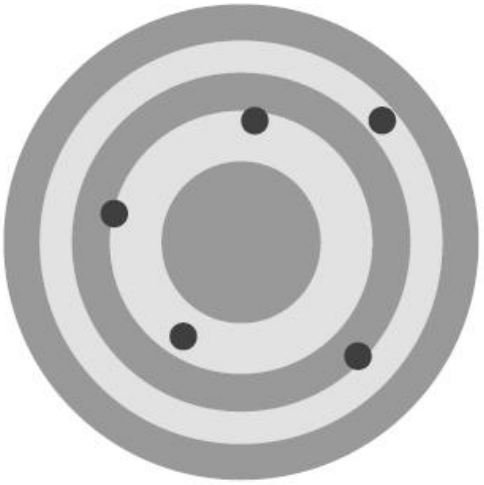
The sensitivity is satisfactory, if:

$$\frac{|m - I|}{m} \times 100 \leq 0.05$$

m = nominal weight of the test load, or its conventional mass (see conditions below), e.g. in grams;

I = indication, e.g. in grams.

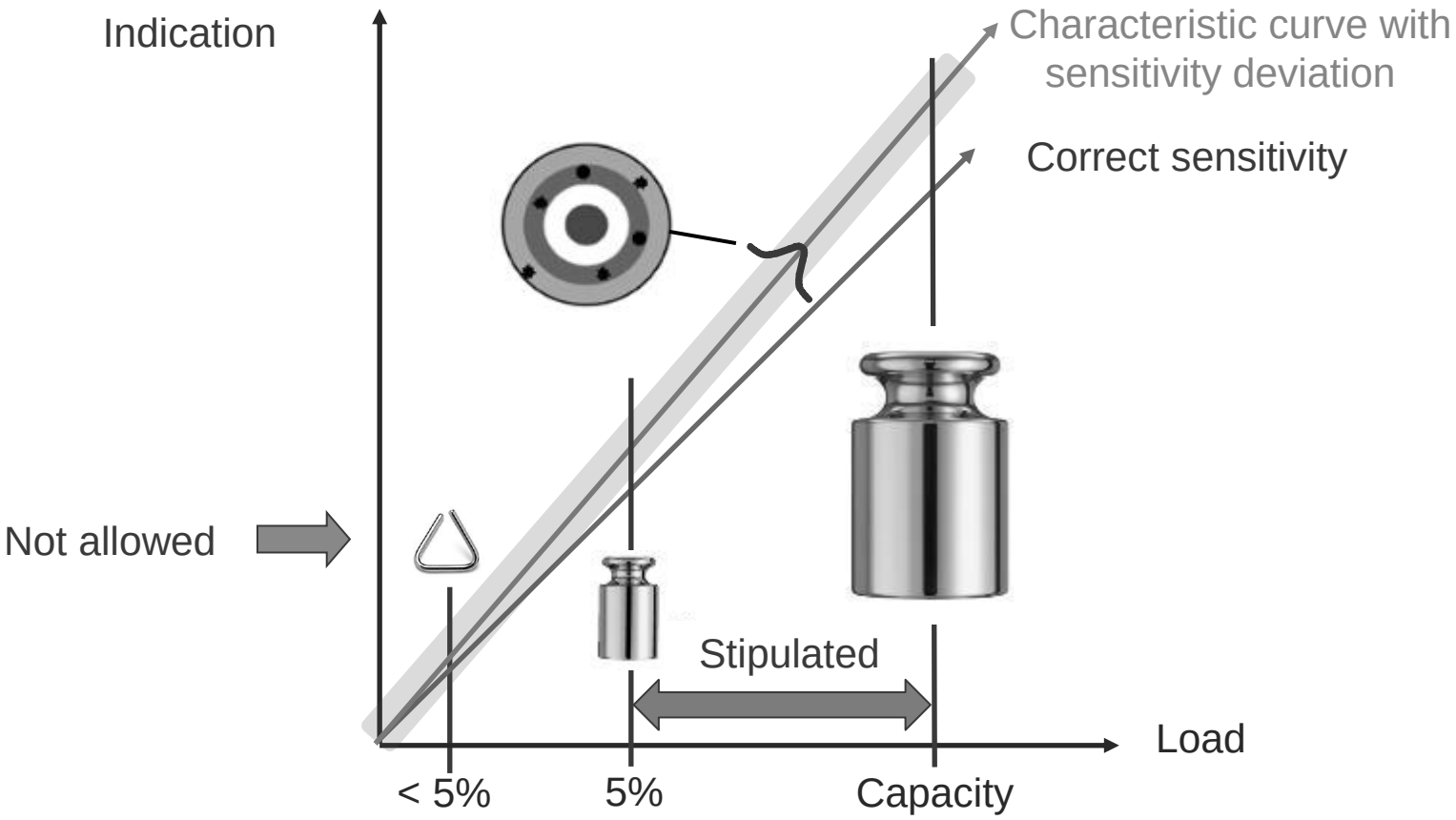
- USP states that other balance parameters also influence the accuracy (eccentricity, Nonlinearity)
- Therefore, the acceptance criterion of an individual parameter shall not be 0.10 % but 0.05 % instead
- Usually it is sufficient to investigate sensitivity only as its impact on accuracy is more dominant
- **Identical approach to USP General Chapters 41 and 1251**



Accurate, but not precise

Which Test Weight for Accuracy?

- Test for accuracy (systematic deviations) with a test weight between 5% and 100% of the capacity
- Using a smaller test weight causes systematic deviations to be obscured by repeatability, and its usage is not permitted



Certificate USP Chapter 41

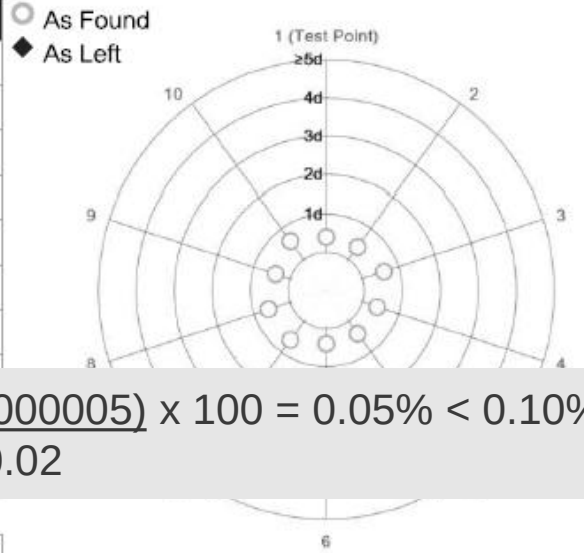
Repeatability

RP_SNW_0.02000g

Smallest Net Weight:	0.02000 g	**Tare Vessel ID:**	N/A
Test Load:	0.02 g	**Tare Vessel Description:**	N/A
Tare Load:	N/A		

	As Found	As Left
1	0.02000 g	N/A
2	0.02000 g	N/A
3	0.02001 g	N/A
4	0.02000 g	N/A
5	0.02000 g	N/A
6	0.02000 g	N/A
7	0.02001 g	N/A
8	0.02001 g	N
9	0.02000 g	N
10	0.02001 g	N

Mean Value	**0.020004 g**	**N/A**
Standard Deviation	**0.000005 g**	**N/A**
Calculation [1]	**0.0516 %**	**N/A**
Assessment [2]	**0.05 %** ✓	**N**
Requirement	**0.10 %**	**N**
Minimum Weight [3]	**0.01033 g**	**N/A**



The "d" in the graph represents the readability of the range/interval in which the test was performed.

The mean value.

$$\frac{2 \times (0.000005)}{0.02} \times 100 = 0.05\% < 0.10\%$$

$$\frac{2 \times (0.000005)}{0.10\%} = 0.01\ g$$

Certificate USP Chapter 41

Accuracy

Linearity

As Found

	Tare Load	Test Load	CMV	Indication	Deviation [1]	Requirement
1	0 g	50 g	49.99995 g	49.99997 g	0.00002 g ✓	0.02500 g
2	0 g	100 g	99.99999 g	100.00000 g	0.00001 g ✓	0.05000 g
3	0 g	150 g	149.99994 g	149.99991 g	-0.00003 g ✓	0.07500 g
4	0 g	200 g	199.99986 g	199.99985 g	-0.00001 g ✓	0.10000 g

[1] The linearity test is passed if the maximum deviation ≤ 0.05 % of the test load value. The requirement for the assessment of an individual balance property in respect to accuracy is 0.05 %. This ensures adherence to the overall accuracy requirement of 0.10 % because other balance properties might also limit the accuracy of the instrument.

Sensitivity

The largest test point of the linearity test is also used to assess sensitivity.

- Test Load 200 g

$$\frac{199.99986 - 199.99985}{199.99986} \times 100 = 0.00001\% < 0.05\%$$

USP Chapter 41&1251 and ACC

	Reference Value	Indication	Error of Indication	Tolerance	g
1	0.0000 g	0.0000 g	0.0000 g	0.05%x10g	0.005g
2	0.0010 g	0.0010 g	0.0000 g	0.05%x10g	0.005g
3	0.0050 g	0.0050 g	0.0000 g	0.05%x10g	0.005g
4	0.0100 g	0.0100 g	0.0000 g	0.05%x10g	0.005g
5	0.0500 g	0.0500 g	0.0000 g	0.05%x10g	0.005g
6	0.1000 g	0.1000 g	0.0000 g	0.05%x10g	0.005g
7	0.5000 g	0.5000 g	0.0000 g	0.05%x10g	0.005g
8	49.9999 g	49.9999 g	0.0000 g	0.05%x50g	0.025g
9	100.0000 g	100.0000 g	0.0000 g	0.05%x100g	0.05g
10	149.9999 g	150.0000 g	0.0001 g	0.05%x150g	0.075g
11	199.9999 g	199.9999 g	0.0000 g	0.05%x200g	0.1g

USP41& USP1251

5% test Repeatability, Tolerance 0.10%

5-100% test Accuracy, Tolerance 0.05%

Minimum Weight from USP and GWP

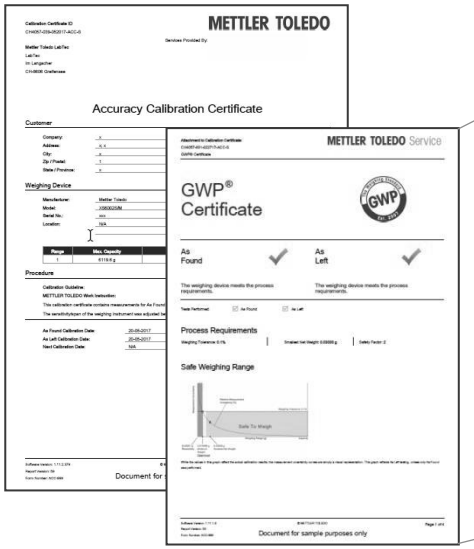
Minimum Weight form USP

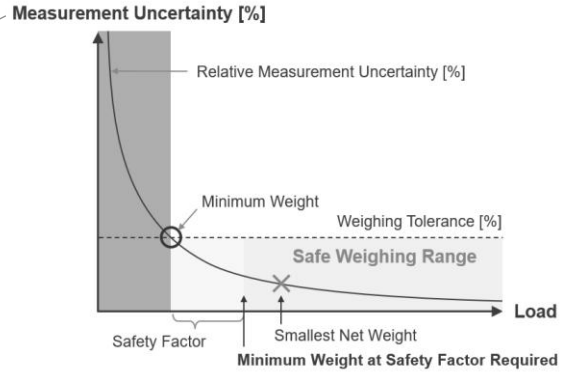
	As Found	As Left
1	0,02000 g	N/A
2	0,02000 g	N/A
3	0,02001 g	N/A
4	0,02000 g	N/A
5	0,02000 g	N/A
6	0,02000 g	N/A
7	0,02001 g	N/A
8	0,02001 g	N/A
9	0,02000 g	N/A
10	0,02001 g	N/A

Mean Value	0.020004 g	N/A
Standard Deviation	0.000005 g	N/A
Calculation [1]	0.0516 %	N/A
Assessment [2]	0.05 % ✓	N/A
Requirement	0.10 %	N/A
Minimum Weight [3]	0.01033 g	N/A

- The minimum weight from test of Repeatability
- External
- Minimum Weight Smaller than GWP Certificate

Minimum Weight form GWP





- The minimum weight from relative uncertainty
- Internal
- Minimum Weight bigger than USP41

Good Weighing Practice (GWP®)

GWP Verification
Life-time certification of weighing process incl. Routine Testing

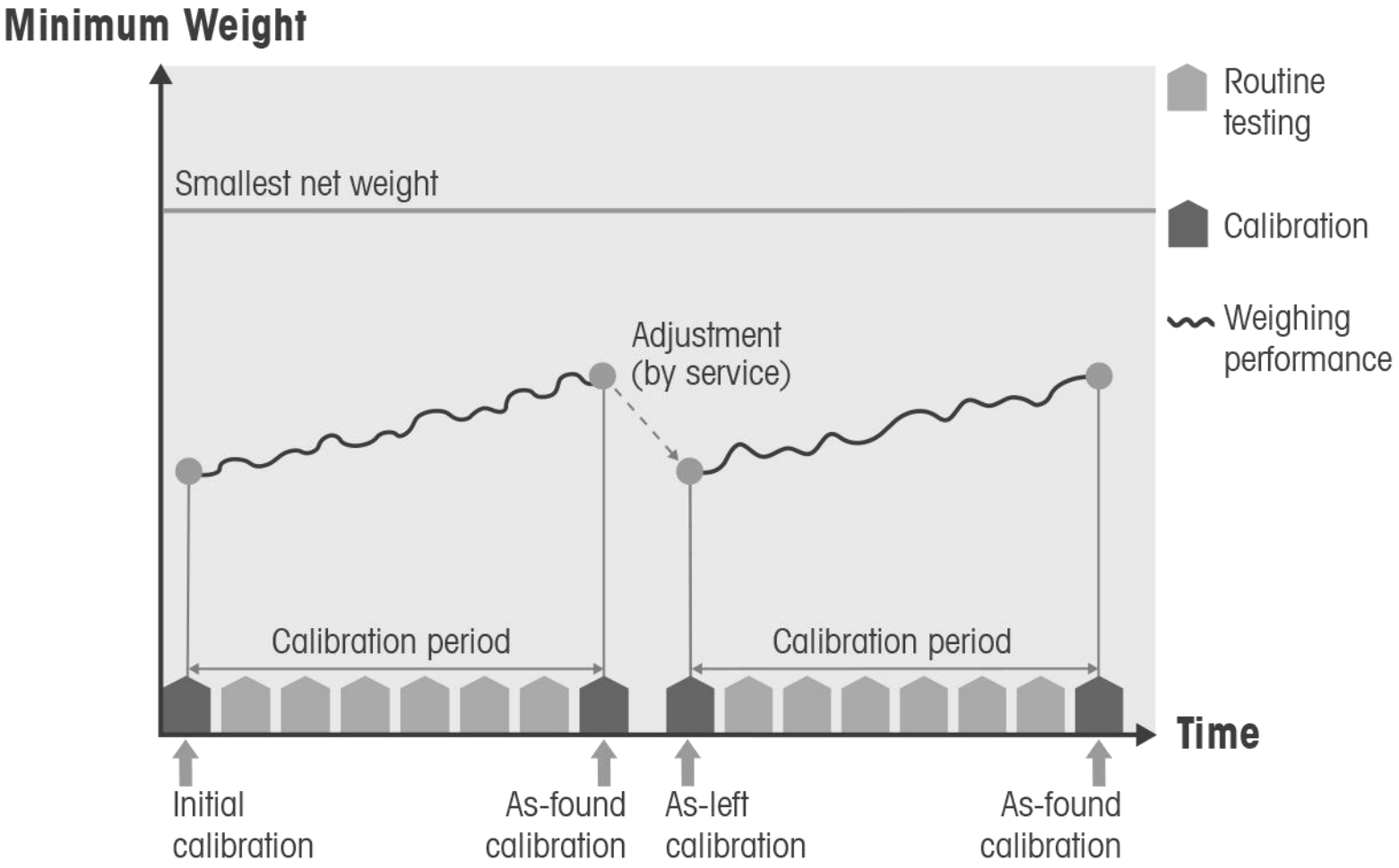
Equipment Performance

Weighing instruments must be periodically calibrated and checked to ensure compliance with pre-defined requirements. Performance checks must be carried out between calibrations.

In addition to testing weighing instruments with external weights, it is accepted practice to adjust the instruments by means of built-in weights. This makes it possible to reduce the frequency of sensitivity tests with external reference weights.

- GWP®, the scientific standard for the life-cycle management of weighing instruments, developed by Mettler-Toledo
- It consists of three pillars which together provide a sustainable and efficient balance quality management
  - Calibration
  - Routine testing (performance checks)
  - Internal adjustment (by built-in weights)

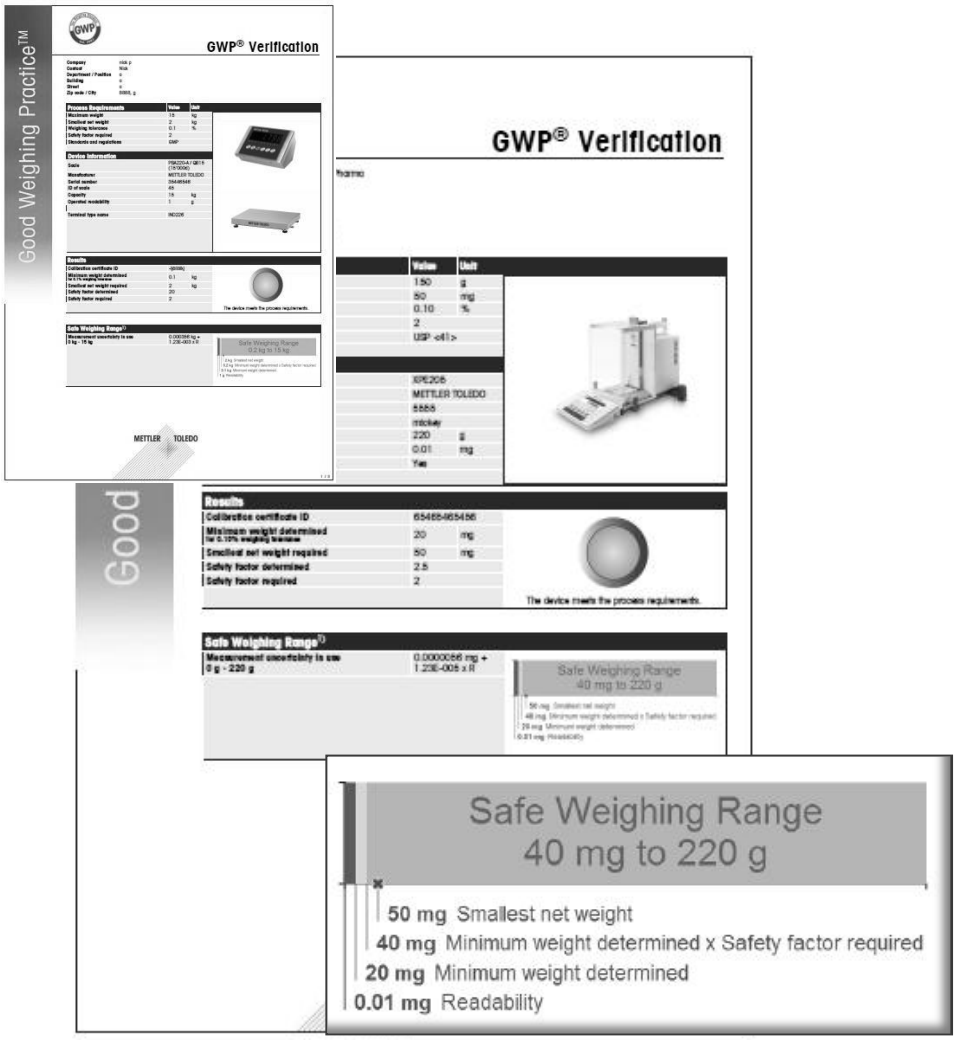
Monitor Your Weighing Performance Over Time



Monitor your weighing performance in between calibrations with routine testing

consistent accuracy • early warning

What does GWP® Verification offer?



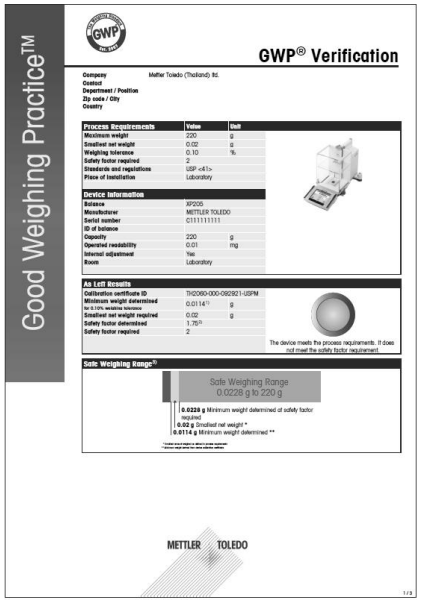
Certifies the accuracy of the device for the weighing process

- Documents whether the accuracy of the scale, based on minimum weight and safety factor, satisfies the process requirements

- Determines the minimum weight based on the calibration of the scale and verifies that the smallest net weight is in the safe weighing range

GWP Verification

GWP Verification


Good Weighing Practice™

GWP® Verification

Company	Mettler Toledo (Thailand) ltd.
Contact	
Department / Position	
Zip code / City	
Country	

Process Requirements	Value	Unit
Maximum weight	220	g
Smallest net weight	0.02	g
Weighing tolerance	0.10	%
Safety factor required	2	
Standards and regulations	USP <41>	
Price of toxicitation	Laboratory	

Device Information		
Balance	XP205	
Manufacturer	METTLER TOLEDO	
Serial number	C111111111	
ID of balance		
Capacity	220	g
Operated readability	0.01	mg
Internal adjustment	Yes	
Room	Laboratory	

As Left Results		
Calibration certificate ID	TH2090-000-092921-USFM	
Minimum weight determined for 0.10% weighing tolerance	0.0114[1]	g
Smallest net weight required	0.02	g
Safety factor determined	1.75[2]	
Safety factor required	2	

The device meets the process requirements. It does not meet the safety factor requirement.

Safe Weighing Range[3]

METTLER TOLEDO

Risk Assessment	
Weighing tolerance	0.10%
Business impact of inaccurate measurements	High
Consumer/environment impact of inaccurate measurements	High
Easy detectability of inaccurate measurements	No

Recommended performance verification

Tests		
Maintenance (by service)		Twice a year
Calibration / Minimum weight (by service)		Twice a year
Eccentricity (by user)		Quarterly
Repeatability (by user)		Monthly
Sensitivity (by user)		Weekly
Internal Adjustment (by device)		Daily
Weights		
Weight 1 (Sensitivity and Eccentricity)	200 g **Class**	F2 or better
Weight 2 (Repeatability)	10 g **Class**	F2 or better
Weights recalibration interval[4]		Yearly
Test tolerances[5]		
Sensitivity		
Weight 1	Warning Limit	0.05 g
	Control Limit	0.1 g
Repeatability (minimum number of measurements: 10)		
Weight 2	Warning Limit	0.005 mg
	Control Limit	0.01 mg
Eccentricity		
Weight 1	Warning Limit	0.05 g
	Control Limit	0.1 g

At installation

At calibration

At calibration

Between calibration intervals

Between calibration intervals

Installation & Initial (As Left) Calibration

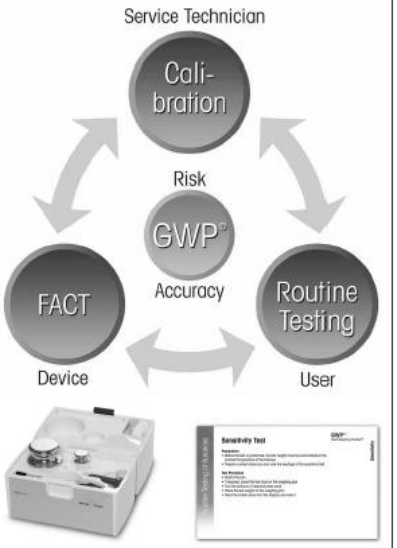
As Found and As Left Calibration

As Found and As Left Calibration

What does GWP® Verification offer?

Good Weighing Practice™

Recommended performance verification			
Tests			
Maintenance (by service)			Twice a year
Calibration (by service)			Twice a year
Minimum weight / GWP certificate (by service)			Twice a year
Linearity (by service)			Twice a year
Eccentricity (by user)			Quarterly
Repeatability (by user)			Monthly
Sensitivity (by user)			Weekly
Internal Adjustment (by device)			Daily
Weights			
Weight 1 (Sensitivity and Eccentricity)	200g	Class	F2 or better
Weight 2 (Repeatability)	10g	Class	F2 or better
Weights recalibration interval[2]			Yearly
Test tolerances[3]			
Sensitivity			
Weight 1	Warning Limit		0.05 g
	Control Limit		0.1 g
Repeatability (minimum number of measurements: 10)			
Weight 2	Warning Limit		0.013 mg
	Control Limit		0.025 mg
Eccentricity			
Weight 1	Warning Limit		0.05 g
	Control Limit		0.1 g



A strategy for accurate weighing throughout the entire life cycle of the instrument

- Recommended calibrations and frequency
- Monitoring for the optimum performance verification, including types of test, intervals and SOPs
- Suitable test weights and weight classes
- Test tolerances and acceptance limits (warning and control limits)

Only meaningful and necessary tests are recommended.
In many cases, efforts may be reduced.

All user tests can be Performed with 2 weights

Weight 1: Maximum OIML/ASTM weight, which is less than or equal to the capacity of the scale(except scales with high capacity)

Weight 2: Maximum OIML/ASTM weight that corresponds to the capacity or is 5 % less than this

CarePac
Weights for routine test
200g
10g

XPE 205
220g capacity

Tolerances for Routine tests

Control limit

Sensitivity/Eccentricity the $\frac{\text{WEIGHT TOLERANCE x WEIGHT VALUE}}{2}$

Repeatability the $\frac{\text{SMALLEST NET WEIGHT x TOLERANCE}}{\text{K FACTOR (2)}}$

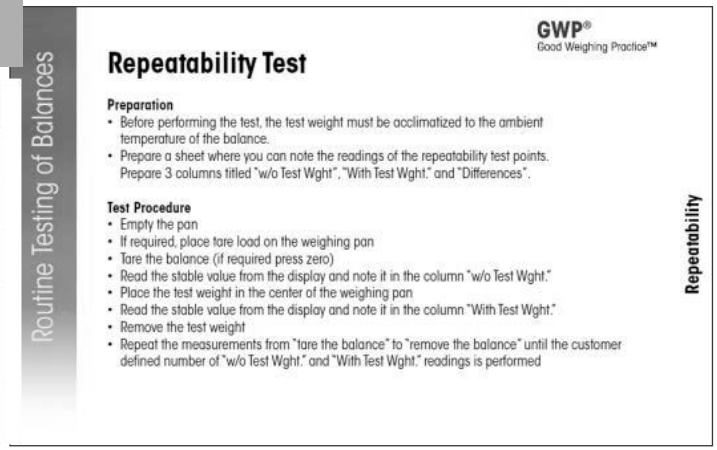
- If the control limit is exceeded: The scale must be characterized as OOT ("out of tolerance") and must not be used any more.

Warning limit

- is equal to the control limit divided by the **safety factor**
- If it is exceeded: No direct action is required. However, the scale should then be monitored somewhat more accurately

The warning limit is the $\frac{\text{CONTROL LIMIT}}{\text{SAFETY FACTOR}}$

Test tolerances[2]		
Sensitivity		
Weight 1	**Warning limit**	50 mg
	Control limit	100 mg
Repeatability (measurements tally (minimum): 10)		
Weight 2	**Warning limit**	8.3 ug
	Control limit	16.7 ug



Routine Testing of Balances

GWP® Good Weighing Practice™

Repeatability Test

Preparation

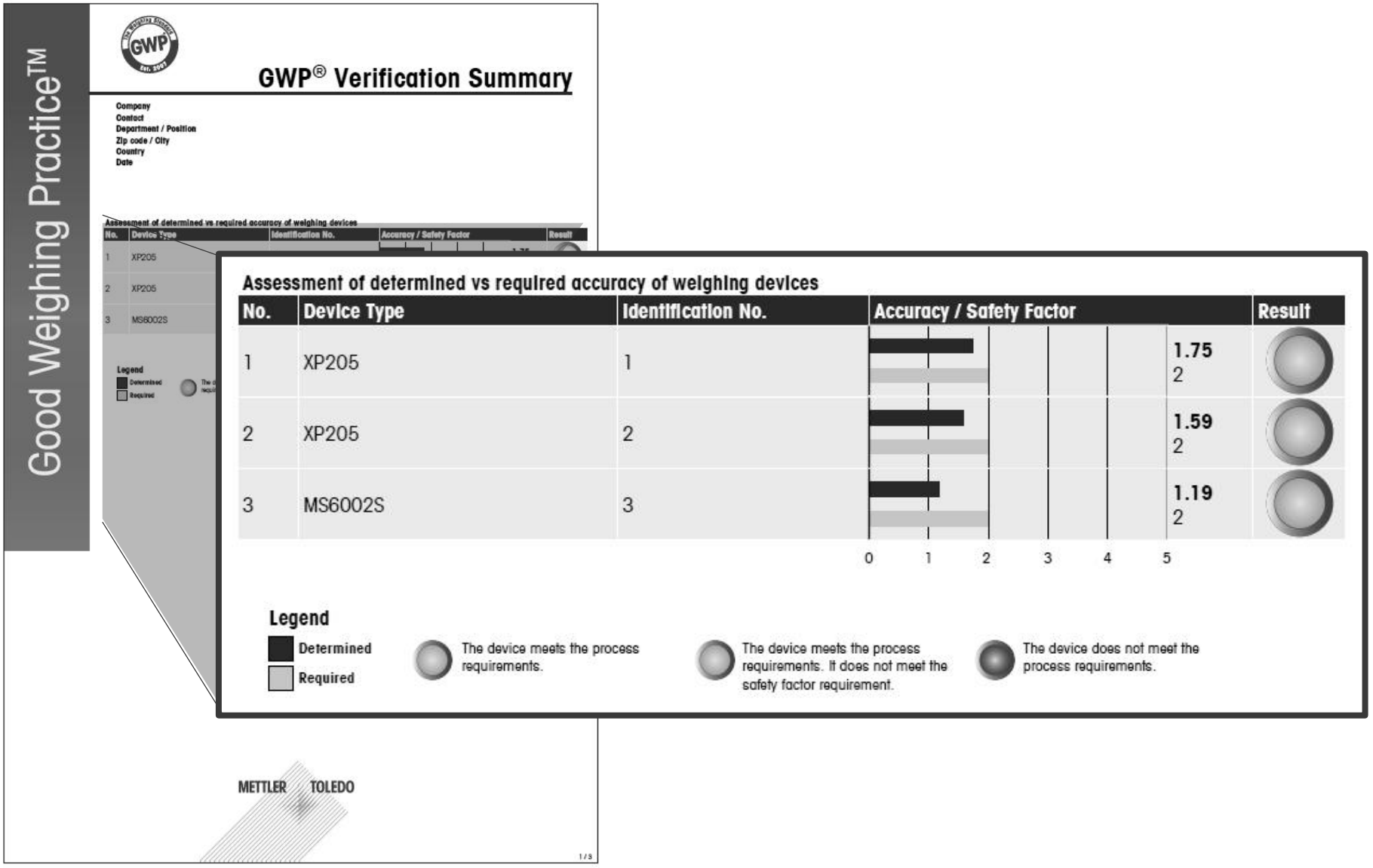
- Before performing the test, the test weight must be acclimatized to the ambient temperature of the balance.
- Prepare a sheet where you can note the readings of the repeatability test points. Prepare 3 columns titled "w/o Test Wght", "With Test Wght." and "Differences".

Test Procedure

- Empty the pan
- If required, place tare load on the weighing pan
- Tare the balance (if required press zero)
- Read the stable value from the display and note it in the column "w/o Test Wght."
- Place the test weight in the center of the weighing pan
- Read the stable value from the display and note it in the column "With Test Wght."
- Remove the test weight
- Repeat the measurements from "tare the balance" to "remove the balance" until the customer defined number of "w/o Test Wght." and "With Test Wght." readings is performed

Repeatability

GWP Verification Summary



GWP Verification Summary

Device Information	Device 1		Device 2		Device 3	
Weighing device	XPE204		XPE206DR		XPE206DR	
Identification No.	No. 1		No. 2		No. 3	
Serial number	B818773819		B713871644		B819822503	
Capacity	220	g	220	g	220	g
Operated readability	0.1	mg	0.005	mg	0.005	mg
Internal adjustment	Yes		Yes		Yes	
Results / Requirements	**Value**	**Unit**	**Value**	**Unit**	**Value**	**Unit**
Weighing tolerance	0.10	%	0.10	%	0.10	%
Maximum weight	220	g	220	g	220	g
Minimum weight determined	0.0966	g	0.00632	g	0.00972	g
Smallest net weight	1	g	0.012	g	0.012	g
Safety factor determined	10.4		1.9		1.23	
Safety factor required	2		2		2	
Standards and regulations	USP <41>		USP <41>		USP <41>	
GWP® Verification No.	XPE204_ B818773819_ 2022-06-01_13-42-42		XPE206DR_ B713871644_ 2022-06-01_13-42-43		XPE206DR_ B819822503_ 2022-06-01_13-44-09	
Calibration certificate ID	TH20xx-xxx-xxxxxx-USPM		TH20xx-xxx-xxxxxx-USPM		TH20xx-xxx-xxxxxx-USPM	
Risk Assessment	**Value**		**Value**		**Value**	
Business impact	High		High		High	
Consumer impact	High		High		High	
Easy detectability	No		No		No	
Harsh environment / extensive use	No		No		No	
Performance Verification	**GWP**	**Current**	**GWP**	**Current**	**GWP**	**Current**
Maintenance	Twice a year	Quarterly	Twice a year	Quarterly	Twice a year	Quarterly
Calibration / Minimum weight	Twice a year	Quarterly	Twice a year	Quarterly	Twice a year	Quarterly
Eccentricity	Quarterly	N/A	Quarterly	N/A	Quarterly	N/A
Repeatability	Monthly	Daily	Monthly	Daily	Monthly	Daily
Sensitivity	Weekly	Daily	Weekly	Daily	Weekly	Daily
Internal adjustment	Daily	Daily	Daily	Daily	Daily	Daily
Test manager	Yes	N/A	Yes	N/A	Yes	N/A
Recalibration of test weights	Yearly	N/A	Yearly	N/A	Yearly	N/A

Legend

Potential cost savings

Potential quality improvements

For each site:

- Summary of the weighing accuracy with color coded presentation
- Summary report for rapid overview of the inventory status
- Recommendations for optimizations

THANK YOU