وزارة التخطيط

الجهاز المركزي للتقييس والسيطرة النوعية

دائرة التقييس – قسم المقاييس

شعبة قياسات الكتلة والضغط

الظروف البيئية وتأثيرها على استقرار قراءة الموازين الالكترونية في مختبر الكتلة

مقدمة من

أحمدعلاء احسان

ماجستير علوم فيزياء

سيف علي سعدي

ماجستير علوم فيزياء

٢٠٢١

Table of Contents

The Aim of Study

The main aim of this study is calculate expanded uncertainty and repeatability uncertainty and calibration electronic weighing instruments. This study shows the effect environmental conditions of calibration on calibration, repeatability uncertainty and expanded uncertainty of electronic weighing instruments into the laboratory of mass in central organization for standardization and quality control (COSQC) for applying ISO/IEC 17025 for accredited laboratories.

Abstract

This study focused on effect environmental conditions of calibration on, repeatability uncertainty and expanded uncertainty of electronic weighing instruments. This study includes three chapters. Chapter one explains the basics of electronic weighing instruments and calibration methods for electronic weighing instruments and explains the importance of estimating the uncertainty according to OIML R76, gives necessary clarifications about measurement uncertainty and spam error. Chapter two have used Two experiments include calibration of two electronic weighing instruments performed into the laboratory of mass in central organization for standardization and quality control (COSQC) for three cases of environmental conditions of calibration on repeatability uncertainty and expanded uncertainty for each electronic weighing instruments for shows what effect of each case on results. Lastly, Chapter three includes the conclusions of the experiments and recommendations which are important to perform correct calibration.

الهدف من الدراسة

الهدف الرئيسي من هذه الدراسة هو حساب اللاتأكدية التكرارية و اللاتأكدية الكلية ومعايرة الموازين الإلكترونية. توضح هذه الدراسة تأثير الظروف البيئية للمعايرة على حسابات اللاتأكدية التكرارية و اللاتأكدية الكلية للموازين الإلكترونية في مختبر الكتلة التابع للجهاز المركزي للتقييس و السيطرة النوعية (COSQC) لتطبيق المواصفة ISO / IEC 17025 للمختبرات المعتمدة.

الخلاصة

ركزت هذه الدراسة على تأثير الظروف البيئية للمعايرة على اللاتأكدية التكرارية و اللاتأكدية الكلية للموازين الإلكترونية. تضمنت هذه الدراسة ثلاثة فصول ، يشرح الفصل الأول أساسيات الموازين الإلكترونية وطرق المعايرة الموازين الإلكترونية ويشرح أهمية حساب اللاتأكدية وفقًا للمواصفة الدولية OIML R76 ، ويعطي التوضيحات اللازمة حول اهمية قياسات اللاتأكدية و الخطأ في القراءات. استخدم الفصل الثاني تجربتان تشملان معايرة ميزانين إلكترونيين تم إجراؤهما في مختبر الكتلة في الجهاز المركزي للتقييس و السيطرة النوعية (COSQC) لثلاث حالات من الظروف البيئية للمعايرة على اللاتأكدية التكرارية و اللاتأكدية الكلية لكل ميزان لاجل توضيح تأثير كل حالة على النتائج القياس وأخيرًا ، تضمن الفصل الثالث استنتاجات التجارب والتوصيات المهمة لإجراء المعايرة الصحيحة.

Chapter one

Introduction and theoretical part

1.1 Introduction

Non-automatic weighing instruments are widely used to determine the value of a load in terms of mass. For some applications specified by national legislation, Non-automatic weighing instruments are subject to legal metrological control – i.e. type approval, verification etc. – but there is an increasing need to have their metrological quality confirmed by calibration, e.g. where required by ISO 9001 or ISO/IEC 17025 standards [1].

1.2 Module

Identifiable part of an instrument that performs a specific function or functions, and that can be separately evaluated according to specific metrological and technical performance requirements in the relevant recommendation. The modules of a weighing instrument are subject to specified partial error limits.

Note: Typical modules of a weighing instrument are: load cell, indicator, analog or digital data processing device, weighing module, terminal and primary display.

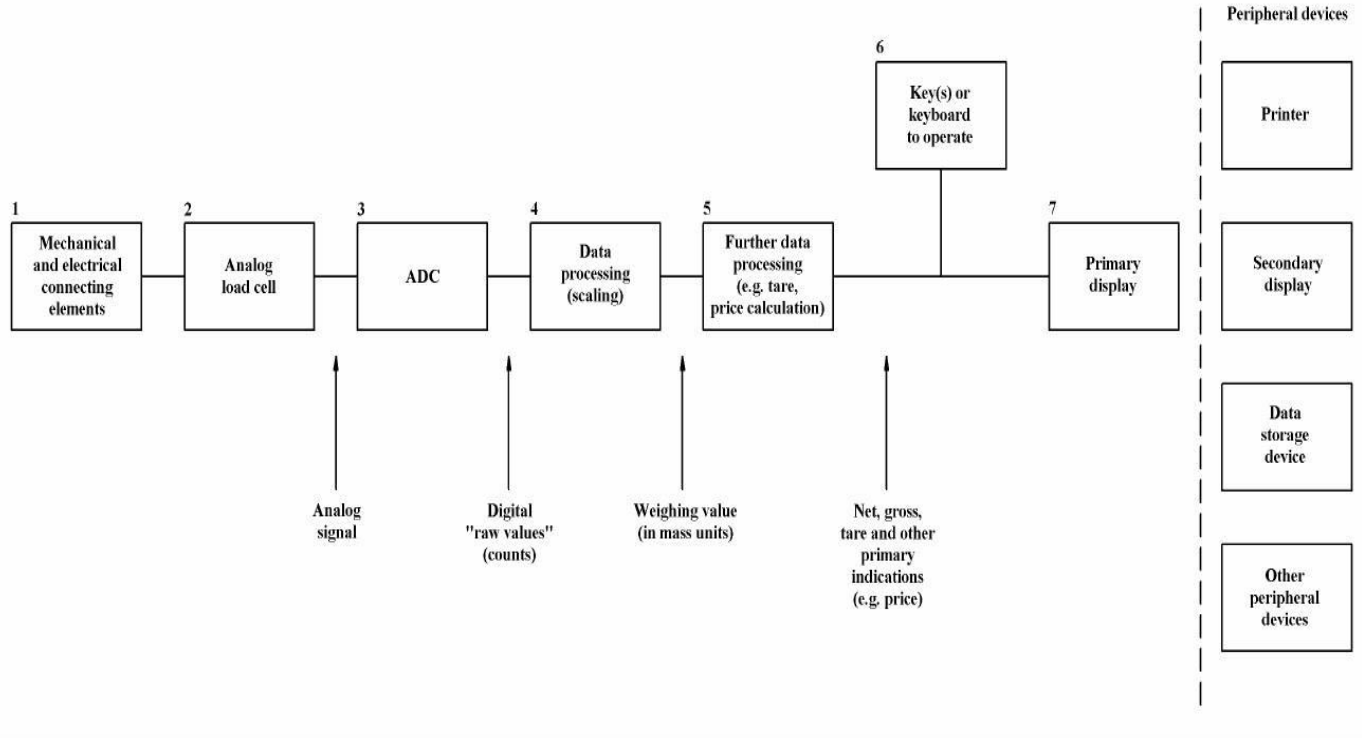


Figure 1: Definition of typical modules according to 1.2 [2].

1.2.1 Load cell [OIML R 60: 2000, 2.1.2]

Force transducer which, after taking into account the effects of the acceleration of gravity and air buoyancy at the location of its use, measures mass by converting the measured quantity (mass) into another measured quantity (output).

Note: Load cells equipped with electronics including amplifier, analog-to-digital converter (ADC), and data processing device (optionally) are called digital load cells (see Figure 1).

1.2.2 Indicator

Electronic device of an instrument that may perform the analog-to-digital conversion of the output signal of the load cell, and which further processes the data, and displays the weighing result in units of mass.

1.2.3 Analog data processing device

Electronic device of an instrument that performs the analog-to-digital conversion of the output signal of the load cell, further processes the data, and supplies the weighing result in a digital format via a digital interface without displaying it. It may optionally have one or more keys (or mouse, touch-screen, etc.) to operate the instrument [2].

1.2.4 Digital data processing device

Electronic device of an instrument that further processes the data, and supplies the weighing result in a digital format via a digital interface without displaying it. It may optionally have one or more keys (or mouse, touch-screen, etc.) to operate the instrument [2].

1.2.5 Terminal

Digital device that has one or more keys (or mouse, touch-screen, etc.) to operate the instrument, and a display to provide the weighing results transmitted via the digital interface of a weighing module or an analog data processing device [2].

1.2.6 Digital display

A digital display can be realized as a primary display or as a secondary display:

a) Primary display: Either incorporated in the indicator housing or in the terminal housing or realized as a display in a separate housing (i.e. terminal without keys), e.g. for use in combination with a weighing module.

b) Secondary display: Additional peripheral device (optional) which repeats the weighing result and any other primary indication, or provides further, non-metrological information.

Note: The terms “primary display” and “secondary display” should not be confused with the terms “primary indication” and “secondary indication” [2].

1.2.7 Weighing module

Part of the weighing instrument that comprises all mechanical and electronic devices (i.e. load receptor, load-transmitting device, load cell, and analog data processing device or digital data processing device) but not having the means to display the weighing result. It may optionally have devices for further processing (digital) data and operating the instrument [2].

1.3 General Aspects of the Calibration

1.3.1 Elements of the calibration

Calibration consists of

1. Applying test loads to the instrument under specified conditions,

2. Determining the error or variation of the indication

3. Evaluating the uncertainty of measurement to be attributed to the results [1].

1.3.2 Preconditions, preparations

Calibration should not be performed unless:

1. The instrument can be readily identified.

2. All functions of the instrument are free from effects of contamination or damage, and functions essential for the calibration operate as intended.

3. Presentation of weight values is unambiguous and indications, where given, are easily readable.

4. The normal conditions of use (air currents, vibrations, stability of the weighing site etc.) are suitable for the instrument to be calibrated.

5. The instrument is energized prior to calibration for an appropriate period, e.g. as long as the warm-up time specified for the instrument, or as set by the user.

6. The instrument is levelled, if applicable.

7. The instrument has been exercised by loading approximately up to the largest test load at least once, repeated loading is advised.

Instruments that are intended to be regularly adjusted before use should be adjusted before the calibration, unless otherwise agreed with the client. Adjustment should be performed with the means that are normally applied by the client, and following the manufacturer's instructions where available. Adjustment could be done by means of external or built-in test loads.

The most suitable operating procedure for high resolution balances (with relative resolution better 1×10^{-5} of full scale) is to perform the adjustment of the balance immediately before the calibration and also immediately before use. Instruments fitted with an automatic zero-setting device or a zero-tracking device should be calibrated with the device operative or not, as set by the client.

For on-site calibration the user of the instrument should be asked to ensure that the normal conditions of use prevail during the calibration. In this way disturbing effects such as air currents, vibrations, or inclination of the measuring platform will, so far as is possible, be inherent in the measured values and will therefore be included in the determined uncertainty of measurement [1].

1.3.3 Place of calibration

Calibration is normally performed in the location where the instrument is being used. If an instrument is moved to another location after the calibration, possible effects from:

1. Difference in local gravity acceleration,

2. Variation in environmental conditions,

3. Mechanical and thermal conditions during transportation

Are likely to alter the performance of the instrument and may invalidate the calibration. Moving the instrument after calibration should therefore be avoided, unless immunity to these effects of a particular instrument, or type of instrument has been clearly demonstrated. Where this has not been demonstrated, the calibration certificate should not be accepted as evidence of traceability [1].

1.4 Instrument with a tare device

Requirements concerning the ranges of a multi-interval instrument apply to the net load, for every possible value of the tare [2].

1.5 Prescribed temperature limits

If no particular working temperature is stated in the descriptive markings of an instrument, this instrument shall maintain its metrological properties within the following temperature limits:

1.6 Special temperature limits

An instrument for which particular limits of working temperature are stated in the descriptive markings shall comply with the metrological requirements within those limits.

The limits may be chosen according to the application of the instrument.

The ranges within those limits shall be at least equal to:

5 °C for instruments of class I;
15 °C for instruments of class II; and
30 °C for instruments of classes III and IIII.

In the absence of a manufacturer's specification, the temperature range (from – 10 °C to + 40 °C) applies [3].

1.7 Temperature effect on no-load indication

The indication at zero or near zero shall not vary by more than one verification scale interval for a difference in ambient temperature of 1 °C for instruments of class I and 5 °C for other classes.

For multi-interval instruments and for multiple range instruments this applies to the smallest verification scale interval of the instrument.

Performance criteria	Load cell	Electronic indicator	Connecting elements, etc.
Temperature effect on no load indication	0.7	0.5	0.5

1.8 Repeatability uncertainty (u_{res})

At least ten repeated measurements must be performed. This test should be done at or near the nominal maximum capacity of the weighing instrument or using the largest load generally weighed in applications. In the case of a zero deviation between the weighings, the instrument shall be reset to zero, without determining the error of the zero indication [4]. The uncertainty due to repeatability of the weighing process,u_{rep} is given by standard deviation s, of several weighing results obtained for the same load under the same conditions. For multiple range instruments, this test shall be carried out for each range used, thus for n measurements:

$$u_{rep} = s = \sqrt{\frac{\sum_{i=1}^{n}(I_i - \bar{I})^2}{n-1}} \qquad \ldots.1$$

Where, $\bar{I}$ is the indication of the weighing instrument and n is the number of repeated weighings [4]:

$$\bar{I} = \frac{1}{n} \sum_{i=1}^{n} I_i \quad \ldots.2$$

1.9 Resolution uncertainty (u_{res})

For balances having the resolution d (equal to the scale interval), the uncertainty of the rounding error,u_{res} for each reading I is [5]:

$$u_{res} = \frac{d}{2\sqrt{3}} \quad \ldots.3$$

1.10 Reference standard uncertainty (u_s)

A source of uncertainty in measurement that should be included in the every uncertainty budget. Uncertainty of a measurement standard designated for the calibration of other measurement standards for quantities of a given kind in a given organization or at a given location [6].

1.11 The combined standard uncertainty (u_c)

The combined standard uncertainty results from both the type A and type B evaluations of the measurements uncertainty. The combined standard uncertainty u_c is based on the parameters described above (which can be grouped to obtain a simplified expression that would better reflect the fact that some of the terms are independent from the applied load, while others are proportional to the weight value) [7].

$$u_c = \alpha + \beta \cdot L \quad \ldots.4$$

When corrections are applied to the error of indication of the weighing instrument, the expression for combined standard uncertainty u_c is:

$$u_c = \sqrt{(u_{rep})^2 + (u_{res})^2 + (u_s)^2 + (u_{ecc})^2} \quad \text{....5}$$

1.12 The expanded uncertainty (U_{exp} or U)

$$U = k\, u_c \quad \text{....6}$$

Where, k=2 [8].

K is constant

Chapter Two

Experimental work

2 Experimental work

In this chapter we will use Two experiments include calibration of two electronic weighing instruments will perform into the laboratory of mass in central organization for standardization and quality control (COSQC) for three cases of environmental conditions of calibration on repeatability uncertainty and expanded uncertainty for each electronic weighing instruments to show what effect of each case on results.

2.1 Instruments and Equipment

- Standard weights
- Thermometer
- Humidity meter
- Pressure meter
- Gloves

Note: Calibration procedure as we wrote in chapter one (1.3 and 1.4) page 3-5.

2.2 Experiments

2.2.1.1 First Experiment without air current:

Electronic weighing instrument it max range is 510 g and division is 0.0001 g (0.1 mg) and was without air current and temperature was 17.20 as shown in calibration certificate of this experiment below:

Calibration certificate

(FOR-TC-012-1)

Accredited Lab — IQAS — Accreditation no. CL 003

Central Organization for Standardization and Quality Control (COSQC)
Metrology Department / Mass & Pressure section / Mass Lab.
P.O. Box13032 Aljadria street, Baghdad ,Tel:7765180 E-Mail : cosqc@cosqc.gov.iq

Certificate No: MAS/ - /2021
Date of issue : 31 / 10 /2021

Customer	
Name:	الجهاز المركزي للتقييس و السيطرة النوعية / قسم المقاييس
Address:	بغداد

Item under calibration

Description:	**Electronic Weighing Instrument**				
Manufacturer:	**Mettler Toledo**				
Model:	**AX 504**				
Serial number:	**1121323127**				
Other identification:	**Max: 510 g**	**Class I**	**d= 0.1 mg**	**e=1 mg**	**min: 0.1 g**
Date of reception:	**/**	**Order No.: /**			
Condition of reception:	**As Found**				

Standard(s) used in the calibration

Description:	**Set of weights (1mg – 100g)**	**Set of weights (100 g – 5 kg)**	
Manufacturer:	**Oertling**	**Oertling**	
Model:	**/**	**/**	
Serial number:	**801532**	**801535**	
Other identification:	**W 12**	**W10**	

Calibration information

Date of calibration:	**14 / 10 / 2021**
Place of calibration:	المختبر الكتلة
Method(s) of calibration:	**Calibration method using a set of mass Accuracy Class (E2) Base down on OIML R76-1:2006**
Calibrated quantity:	**Mass**
Results of calibration:	**Attached a complete result in Annex 1 of this certificate**
Measurement uncertainty:	**The reported expanded uncertainty is based on Guide JCGM 100:2008 and EA cg NO.18V4.0(11/2015) Standard Uncertainty multiplied by coverage factor k=2 to give confidence level of 95%. The uncertainty doesn't include the eccentricity or hysterics errors. The end user shall estimate both eccentricity and hysterics according to real measurement procedure.**
Metrological traceability:	**The traceability of measurement results to the SI units is issued by the National standard maintained at Central Organization for standardization and Quality Control through Calibration certificate issued from PTB:(W41,W42,W44,W45,W46)**
Environmental conditions of calibration:	**Temp. : (17.20 ºC) R. H. : (38.5 %) Pressure: (1012.42 mbar)**
Observations, opinions or Recommendations:	**The results are within the tolerance of OIML R76-1:2006**

Calibration certificate (FOR-TC-012-1)
Central Organization for Standardization and Quality Control (COSQC)
Metrology Department/Mass & pressure section/Mass Lab.
P.O. Box13032 Aljadria street, Baghdad ,Tel:7765180 E-Mail : cosqc@cosqc.gov.iq

Annex1/Results

Before adjustment

Load (g)	Reading(g)	Error (g)
1	1.0000	0.0000
50	50.0000	0.0000
100	100.0000	0.0000
300	299.9991	-0.0009
510	509.9992	-0.0008

After adjustment

1-Weighing Performance:

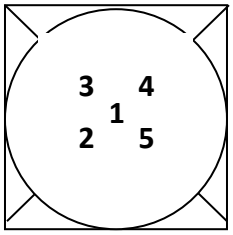
Load (g)	Increasing Load		Load (g)	Decreasing Load	
	Reading(g)	Error (g)		Reading(g)	Error (g)
1	1.0000	0.0000	510	509.9993	-0.0007
50	50.0000	0.0000	300	299.9992	-0.0008
100	100.0000	0.0000	100	100.0000	0.0000
300	299.9992	-0.0008	50	50.0000	0.0000
510	509.9993	-0.0007	1.0	1.0000	0.0000

2-Repeatability Test:

Load(g)	Reading(g)					
100%Max	499.9990	499.9989	499.9989	499.9989	499.9989	499.9989
50%Max	199.9994	199.9993	199.9993	199.9993	199.9993	199.9993

3-Eccentricity Test: **(Difference from center)**

Position No.	1	2	3	4	5
Load(g)	150				
Reading (g)	149.9998	149.9997	149.9998	149.9999	149.9998
Error (g)	----	-0.0001	0.0000	0.0001	0.0000



4-TheExpanded Uncertainty:

load(g)	Expanded Uncertainty ±(mg)
500	1.05
200	0.43

Table 2.1: The date that taken from electronic weighing instrument and mass that used to calibration it from latest certificate of mass.

	Half Max	Max
Range (g)	**200.0000**	**500.0000**
U expanded	**0.079**	**0.081**
Tolerance (OIML)	**0.30**	**0.80**
Resolution	**0.0001**	**0.0001**

Note: When d is division or Resolution

Temp. : (17.20 ºC) **R. H.: (38.5 %)** **Pressure: (1012.42 mbar)**

Table 2.2: Reading five different value of weights that cover all range of electronic weighing instrument.

Load (g)	Increasing Load	
	Reading(g)	Error (g)
1	1.0000	0.0000
50	50.0000	0.0000
100	100.0000	0.0000
300	299.9992	-0.0008
510	509.9993	-0.0007

Table 2.3: Repeatability test

Load(g)	Reading(g)					
100%Max	499.9990	499.9989	499.9989	499.9989	499.9989	499.9989
50%Max	199.9994	199.9993	199.9993	199.9993	199.9993	199.9993

Note: How calculate Repeatability as show in chapter 1 (1.8) page 6-7

Table 2.4: The Expanded Uncertainty of electronic weighing instrument

load(g)	Expanded Uncertainty ±(mg)
500	1.05
200	0.43

Note: How calculate uncertainty as show in chapter 1 (1.8- 1.12) page 6-8

2.2.1.2 First Experiment with air current:

Electronic weighing instrument it max range is 510 g and division is 0.0001 g (0.1 mg) and was with air current and temperature was 17.48 as shown in calibration certificate of this experiment below:

Calibration certificate

(FOR-TC-012-1)

Accredited Lab
Accreditation no. CL 003

ntral Organization for Standardization and Quality Control (COSQC)
Metrology Department / Mass & Pressure section / Mass Lab.
P.O. Box13032 Aljadria street, Baghdad ,Tel:7765180 E-Mail : cosqc@cosqc.gov.iq

Certificate No: MAS/ - /2021
Date of issue : 31 / 10 /2021

Customer	
Name:	الجهاز المركزي للتقييس و السيطرة النوعية / قسم المقاييس
Address:	بغداد

Item under calibration

Description:	**Electronic Weighing Instrument**				
Manufacturer:	**Mettler Toledo**				
Model:	**AX 504**				
Serial number:	**1121323127**				
Other identification:	**Max: 510 g**	**Class I**	**d= 0.1 mg**	**e=1 mg**	**min: 0.1 g**
Date of reception:	**/**	**Order No.: /**			
Condition of reception:	**As Found**				

Standard(s) used in the calibration

Description:	**Set of weights (1mg – 100g)**	**Set of weights (100 g – 5 kg)**	
Manufacturer:	**Oertling**	**Oertling**	
Model:	**/**	**/**	
Serial number:	**801532**	**801535**	
Other identification:	**W 12**	**W10**	

Calibration information

Date of calibration:	**14 / 10 / 2021**
Place of calibration:	المختبر الكتلة
Method(s) of calibration:	**Calibration method using a set of mass Accuracy Class (E2) Base down on OIML R76-1:2006**
Calibrated quantity:	**Mass**
Results of calibration:	**Attached a complete result in Annex 1 of this certificate**
Measurement uncertainty:	**The reported expanded uncertainty is based on Guide JCGM 100:2008 and EA cg NO.18V4.0(11/2015) Standard Uncertainty multiplied by coverage factor k=2 to give confidence level of 95%. The uncertainty doesn't include the eccentricity or hysterics errors. The end user shall estimate both eccentricity and hysterics according to real measurement procedure.**
Metrological traceability:	**The traceability of measurement results to the SI units is issued by the National standard maintained at Central Organization for standardization and Quality Control through Calibration certificate issued from PTB:(W41,W42,W44,W45,W46)**
Environmental conditions of calibration:	**Temp. : (17.48 ºC) R. H. : (36.5 %) Pressure: (1012.42 mbar)**
Observations, opinions or Recommendations:	**The results are within the tolerance of OIML R76-1:2006**

Ref:PROC-TC-012

Calibration certificate (FOR-TC-012-1)
Central Organization for Standardization and Quality Control (COSQC)
Metrology Department/Mass & pressure section/Mass Lab.
P.O. Box13032 Aljadria street, Baghdad ,Tel:7765180 E-Mail : cosqc@cosqc.gov.iq

Annex1/Results

Before adjustment

Load (g)	Reading(g)	Error (g)
1	1.0001	0.0001
50	50.0012	0.0012
100	100.0010	0.0010
300	299.9997	-0.0003
510	509.9987	-0.0013

After adjustment

1-Weighing Performance:

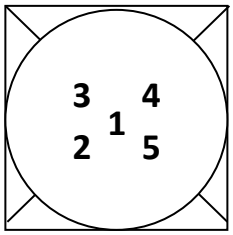
Load (g)	Increasing Load		Load (g)	Decreasing Load	
	Reading(g)	Error (g)		Reading(g)	Error (g)
1	1.0001	0.0001	510	509.9987	-0.0013
50	50.0012	0.0012	300	299.9997	-0.0003
100	100.0010	0.0010	100	100.0010	0.0010
300	299.9997	-0.0003	50	50.0012	0.0012
510	509.9987	-0.0013	1.0	1.0001	0.0001

2-Repeatability Test:

Load(g)	Reading(g)					
100%Max	499.9990	500.0008	500.0002	500.0007	499.9997	499.9994
50%Max	200.0003	200.0001	200.0005	200.0007	200.0002	200.0006

3-Eccentricity Test: **(Difference from center)**

Position No.	1	2	3	4	5
Load(g)	150				
Reading (g)	149.9998	149.9999	149.9998	149.9999	149.9998
Error (g)	----	0.0001	0.0000	0.0001	0.0000



4-TheExpanded Uncertainty:

load(g)	Expanded Uncertainty ±(mg)
500	1.21
200	0.47

Table 2.5: The date that taken from electronic weighing instrument and mass that used to calibration it from latest certificate of mass.

	Half Max	Max
Range (g)	**200.0000**	**500.0000**
U expanded	**0.079**	**0.081**
Tolerance (OIML)	**0.30**	**0.80**
Resolution	**0.0001**	**0.0001**

Note: When d is division or Resolution

Temp. : (17.48 ºC) **R. H.: (36.5 %)** **Pressure: (1012.42 mbar)**

Table 2.6: Reading five different value of weights that cover all range of electronic weighing instrument

Load (g)	Increasing Load	
	Reading(g)	Error (g)
1	1.0001	0.0001
50	50.0012	0.0012
100	100.0010	0.0010
300	299.9997	-0.0003
510	509.9987	-0.0013

Table 2.7: Repeatability test

Load(g)	Reading(g)					
100%Max	499.9990	500.0008	500.0002	500.0007	499.9997	499.9994
50%Max	200.0003	200.0001	200.0005	200.0007	200.0002	200.0006

Table 2.8: The Expanded Uncertainty of electronic weighing instrument

load(g)	Expanded Uncertainty ±(mg)
500	1.21
200	0.47

2.2.1.3 First Experiment with air current:

Electronic weighing instrument it max range is 510 g and division is 0.0001 g (0.1 mg) and was without air current and temperature was 26.51 as shown in calibration certificate of this experiment below:

Calibration certificate

(FOR-TC-012-1)

Central Organization for Standardization and Quality Control (COSQC)

Metrology Department / Mass & Pressure section / Mass Lab.

P.O. Box13032 Aljadria street, Baghdad ,Tel:7765180 E-Mail : cosqc@cosqc.gov.iq

Accredited Lab — Accreditation no. CL 003

Certificate No: MAS/ - /2021

Date of issue : 31 / 10 /2021

Customer	
Name:	الجهاز المركزي للتقييس و السيطرة النوعية / قسم المقاييس
Address:	بغداد

Item under calibration

Description:	Electronic Weighing Instrument				
Manufacturer:	Mettler Toledo				
Model:	AX 504				
Serial number:	1121323127				
Other identification:	Max: 510 g	Class I	d= 0.1 mg	e=1 mg	min: 0.1 g
Date of reception:	/	Order No.: /			
Condition of reception:	As Found				

Standard(s) used in the calibration

Description:	Set of weights (1mg – 100g)	Set of weights (100 g – 5 kg)	
Manufacturer:	Oertling	Oertling	
Model:	/	/	
Serial number:	801532	801535	
Other identification:	W 12	W10	

Calibration information

Date of calibration:	14 / 10 / 2021
Place of calibration:	المختبر الكتلة
Method(s) of calibration:	Calibration method using a set of mass Accuracy Class (E2) Base down on OIML R76-1:2006
Calibrated quantity:	Mass
Results of calibration:	Attached a complete result in Annex 1 of this certificate
Measurement uncertainty:	The reported expanded uncertainty is based on Guide JCGM 100:2008 and EA cg NO.18V4.0(11/2015) Standard Uncertainty multiplied by coverage factor k=2 to give confidence level of 95%. The uncertainty doesn't include the eccentricity or hysterics errors. The end user shall estimate both eccentricity and hysterics according to real measurement procedure.
Metrological traceability:	The traceability of measurement results to the SI units is issued by the National standard maintained at Central Organization for standardization and Quality Control through Calibration certificate issued from PTB:(W41,W42,W44,W45,W46)
Environmental conditions of calibration:	Temp. : (26.51 ºC) R. H. : (37.8 %) Pressure: (1012.42 mbar)
Observations, opinions or Recommendations:	The results are within the tolerance of OIML R76-1:2006

Ref:PROC-TC-012

Calibration certificate (FOR-TC-012-1)
Central Organization for Standardization and Quality Control (COSQC)
Metrology Department/Mass & pressure section/Mass Lab.
P.O. Box13032 Aljadria street, Baghdad ,Tel:7765180 E-Mail : cosqc@cosqc.gov.iq

Annex1/Results

Before adjustment

Load (g)	Reading(g)	Error (g)
1	1.0001	0.0001
50	50.0003	0.0003
100	100.0002	0.0002
300	299.9996	-0.0004
510	509.9993	-0.0007

After adjustment

1-Weighing Performance:

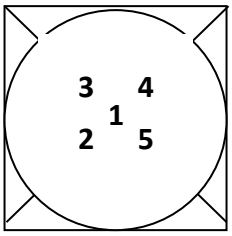
Load (g)	Increasing Load		Load (g)	Decreasing Load	
	Reading(g)	Error (g)		Reading(g)	Error (g)
1	1.0001	0.0001	510	509.9994	-0.0006
50	50.0004	0.0004	300	299.9997	-0.0003
100	100.0003	0.0003	100	100.0003	0.0003
300	299.9997	-0.0003	50	50.0004	0.0004
510	509.9994	-0.0006	1.0	1.0001	0.0001

2-Repeatability Test:

Load(g)	Reading(g)					
100%Max	499.9996	499.9997	499.9997	499.9997	499.9997	499.9997
50%Max	200.0003	200.0004	200.0004	200.0004	200.0004	200.0004

3-Eccentricity Test: **(Difference from center)**

Position No.	1	2	3	4	5
Load(g)	150				
Reading (g)	149.9998	149.9999	149.9998	149.9999	149.9998
Error (g)	----	0.0001	0.0000	0.0001	0.0000



4-TheExpanded Uncertainty:

load(g)	Expanded Uncertainty ±(mg)
500	1.05
200	0.43

Table 2.9: The date that taken from electronic weighing instrument and mass that used to calibration it from latest certificate of mass.

	Half Max	Max
Range (g)	**200.0000**	**500.0000**
U expanded	**0.079**	**0.081**
Tolerance (OIML)	**0.30**	**0.80**
Resolution	**0.0001**	**0.0001**

Note: When d is division or Resolution

Temp. : (26.51 ºC) **R. H.: (37.8 %)** **Pressure: (1012.42 mbar)**

Table 2.10: Reading five different value of weights that cover all range of electronic weighing instrument

Load (g)	Increasing Load	
	Reading(g)	Error (g)
1	1.0001	0.0001
50	50.0004	0.0004
100	100.0003	0.0003
300	299.9997	-0.0003
510	509.9994	-0.0006

Table 2.11: Repeatability test

Load(g)	Reading(g)					
100%Max	499.9996	499.9997	499.9997	499.9997	499.9997	499.9997
50%Max	200.0003	200.0004	200.0004	200.0004	200.0004	200.0004

Table 2.12: The Expanded Uncertainty of electronic weighing instrument

load(g)	Expanded Uncertainty ±(mg)
500	1.05
200	0.43

2.2.1.4 Comparing between the results of three different cases

Table 2.13: Comparing between the results of three different cases for five weights

Load (g)	without air current Temperature (17.20)		with air current Temperature (17.48)		without air current Temperature (26.51)	
	Reading(g)	Error (g)	Reading(g)	Error (g)	Reading(g)	Error (g)
1	1.0000	0.0000	1.0001	0.0001	1.0001	0.0001
50	50.0000	0.0000	50.0012	0.0012	50.0004	0.0004
100	100.0000	0.0000	100.0010	0.0010	100.0003	0.0003
300	299.9992	-0.0008	299.9997	-0.0003	299.9997	-0.0003
510	509.9993	-0.0007	509.9987	-0.0013	509.9994	-0.0006

We noticed the reading of electronic weighing instrument of cases without air current almost not change Reading even with different Temperatures and observed change with air current.

Table 2.14: Comparing between the results of three different cases for max and half of Repeatability test

Load(g)	Reading(g) without air current and the Temperature is (17.20)					
100%Max	499.9990	499.9989	499.9989	499.9989	499.9989	499.9989
50%Max	199.9994	199.9993	199.9993	199.9993	199.9993	199.9993
Load(g)	Reading(g) without air current and the Temperature is (7.48)					
100%Max	499.9990	500.0008	500.0002	500.0007	499.9997	499.9994
50%Max	200.0003	200.0001	200.0005	200.0007	200.0002	200.0006
Load(g)	Reading(g) without air current and the Temperature is (26.51)					
100%Max	499.9996	499.9997	499.9997	499.9997	499.9997	499.9997
50%Max	200.0003	200.0004	200.0004	200.0004	200.0004	200.0004

We noticed the Repeatability of cases without air current almost not change Reading even with different Temperatures and observed change with air current.

Table 2.15: Comparing between the results of three different cases of Expanded Uncertainty of electronic weighing instrument

load(g)	Expanded Uncertainty ±(mg) without air current Temperature (26.51)	Expanded Uncertainty ±(mg) without air current Temperature (26.51)	Expanded Uncertainty ±(mg) without air current Temperature (26.51)
500	1.05	1.21	1.05
200	0.43	0.47	0.43

We noticed the Expanded Uncertainty of cases without air current almost not change Reading even with different Temperatures and observed change with air current.

2.2.2.1 Second Experiment without air current:

Electronic weighing instrument it max range is 10100 g and division is 0.001 g (1 mg) and was without air current and temperature was 18.37 as shown in calibration certificate of this experiment below:

(FOR-TC-012-1)

Accredited Lab
Accreditation no. CL 003

Calibration certificate

Central Organization for Standardization and Quality Control (COSQC)

Metrology Department / Mass & Pressure section / Mass Lab.

P.O. Box13032 Aljadria street, Baghdad ,Tel:7765180 E-Mail : cosqc@cosqc.gov.iq

Certificate No: MAS/ - /2021
Date of issue : 2 / 11 /2021

Customer	
Name:	الجهاز المركزي للتقييس و السيطرة النوعية / قسم المقاييس
Address:	بغداد

Item under calibration

Description:	Electronic Weighing Instrument				
Manufacturer:	Mettler Toledo				
Model:	XPE 1003SC				
Serial number:	B610195897				
Other identification:	Max: 10100 g	Class I	d= 0.001 g	e= 0.001 g	min: 0.1g
Date of reception:	/	Order No.: /			
Condition of reception:	As Found				

Standard(s) used in the calibration

Description:	Set of weights (1mg – 100g)	Set of weights (100g – 5 kg)	Single weight (10 kg)
Manufacturer:	Oertling	Oertling	Mettler Toledo
Model:	/	/	/
Serial number:	801532	801530	B 249588670
Other identification:	W 12	W 10	W 33

Calibration information

Date of calibration:	31 / 10 / 2021
Place of calibration:	مختبر الكتلة
Method(s) of calibration:	Calibration method using a set of mass Accuracy Class (E2 AND F1) Base down on OIML R76-1:2006
Calibrated quantity:	Mass
Results of calibration:	Attached a complete result in Annex 1 of this certificate
Measurement uncertainty:	The reported expanded uncertainty is based on Guide JCGM 100:2008 and EA cg NO.18V4.0(11/2015) Standard Uncertainty multiplied by coverage factor k=2 to give confidence level of 95%. The uncertainty doesn't include the eccentricity or hysterics errors. The end user shall estimate both eccentricity and hysterics according to real measurement procedure.
Metrological traceability:	The traceability of measurement results to the SI units is issued by the National standard maintained at Central Organization for standardization and Quality Control through Calibration certificate issued from PTB:(W41,W42,W44,W45,W46)
Environmental conditions of calibration:	Temp. : (18.37 ºC) R. H. : (38.4 %) Pressure: (1008.04 mbar)
Observations, opinions or Recommendations:	The results are within the tolerance of OIML R76-1

Ref:PROC-TC-012

Calibration certificate (FOR-TC-012-1)
Central Organization for Standardization and Quality Control (COSQC)
Metrology Department/Mass & pressure section/Mass Lab.
P.O. Box13032 Aljadria street, Baghdad ,Tel:7765180 E-Mail : cosqc@cosqc.gov.iq

Annex1/Results

Before adjustment

Load (g)	Reading(g)	Error (g)
0.1	0.100	0.000
200	200.001	0.001
2000	2000.003	0.003
7000	7000.026	0.026
10100	10100.060	0.060

After adjustment

1-Weighing Performance:

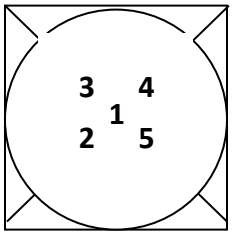
Load (g)	Increasing Load		Load (g)	Decreasing Load	
	Reading(g)	Error (g)		Reading(g)	Error (g)
0.1	0.100	0.000	10100	10100.060	0.060
200	200.001	0.001	7000	7000.026	0.026
2000	2000.003	0.003	2000	2000.003	0.003
7000	7000.026	0.026	200	200.001	0.001
10100	10100.060	0.060	0.1	0.100	0.000

2-Repeatability Test:

Load(g)	Reading(g)					
100%Max	10000.058	10000.058	10000.058	10000.057	10000.057	10000.057
50%Max	5000.015	5000.016	5000.016	5000.016	5000.016	5000.016

3-Eccentricity Test: **(Difference from center)**

Position No.	1	2	3	4	5
Load(g)	2500				
Reading (g)	2500.002	2500.001	2500.002	2500.002	2500.001
Error (g)	----	-0.001	0.000	0.000	-0.001



4-TheExpanded Uncertainty:

load(g)	Expanded Uncertainty ±(g)
10000	0.028
5000	0.011

Table 2.16: The date that taken from electronic weighing instrument and mass that used to calibration it from latest certificate of mass.

	Half Max	Max
Range (g)	**5000**	**10000**
U expanded	**1.170**	**3.408**
Tolerance (OIML)	**8**	**50**
Resolution	**0.001**	**0.001**

Note: When d is division or Resolution

Temp. : (18.37 ºC) **R. H.: (38.4 %)** **Pressure: (1008.04 mbar)**

Table 2.17: Reading five different value of weights that cover all range of electronic weighing instrument.

Load (g)	Increasing Load	
	Reading(g)	Error (g)
0.1	0.100	0.000
200	200.001	0.001
2000	2000.003	0.003
7000	7000.026	0.026
10100	10100.060	0.060

Table 2.18: Repeatability test

Load(g)	Reading(g)					
100%Max	10000.058	10000.058	10000.058	10000.057	10000.057	10000.057
50%Max	5000.015	5000.016	5000.016	5000.016	5000.016	5000.016

Table 2.19: The Expanded Uncertainty of electronic weighing instrument

load(g)	Expanded Uncertainty ±(g)
10000	0.028
5000	0.011

2.2.2.2 Second Experiment without air current:

Electronic weighing instrument it max range is 10100 g and division is 0.001 g (1 mg) and was without air current and temperature was 18.08 as shown in calibration certificate of this experiment below:

Calibration certificate

(FOR-TC-012-1)

Central Organization for Standardization and Quality Control (COSQC)
Metrology Department / Mass & Pressure section / Mass Lab.

P.O. Box13032 Aljadria street, Baghdad ,Tel:7765180 E-Mail : cosqc@cosqc.gov.iq

Accredited Lab — IQAS — Accreditation no. C.L 003

Certificate No: MAS/ - /2021
Date of issue : 2 / 11 /2021

Customer	
Name:	الجهاز المركزي للتقييس و السيطرة النوعية / قسم المقاييس
Address:	بغداد

Item under calibration

Description:	Electronic Weighing Instrument				
Manufacturer:	Mettler Toledo				
Model:	XPE 1003SC				
Serial number:	B610195897				
Other identification:	Max: 10100 g	Class I	d= 0.001 g	e= 0.001 g	min: 0.1g
Date of reception:	/	Order No.: /			
Condition of reception:	As Found				

Standard(s) used in the calibration

Description:	Set of weights (1mg – 100g)	Set of weights (100g – 5 kg)	Single weight (10 kg)
Manufacturer:	Oertling	Oertling	Mettler Toledo
Model:	/	/	/
Serial number:	801532	801530	B 249588670
Other identification:	W 12	W 10	W 33

Calibration information

Date of calibration:	31 / 10 / 2021
Place of calibration:	مختبر الكتلة
Method(s) of calibration:	Calibration method using a set of mass Accuracy Class (E2 AND F1) Base down on OIML R76-1:2006
Calibrated quantity:	Mass
Results of calibration:	Attached a complete result in Annex 1 of this certificate
Measurement uncertainty:	The reported expanded uncertainty is based on Guide JCGM 100:2008 and EA cg NO.18V4.0(11/2015) Standard Uncertainty multiplied by coverage factor k=2 to give confidence level of 95%. The uncertainty doesn't include the eccentricity or hysterics errors. The end user shall estimate both eccentricity and hysterics according to real measurement procedure.
Metrological traceability:	The traceability of measurement results to the SI units is issued by the National standard maintained at Central Organization for standardization and Quality Control through Calibration certificate issued from PTB:(W41,W42,W44,W45,W46)
Environmental conditions of calibration:	Temp. : (18.08 ºC) R. H. : (36.4 %) Pressure: (1008.04 mbar)
Observations, opinions or Recommendations:	The results are within the tolerance of OIML R76-1

Ref:PROC-TC-012

Calibration certificate (FOR-TC-012-1)
Central Organization for Standardization and Quality Control (COSQC)
Metrology Department/Mass & pressure section/Mass Lab.
P.O. Box13032 Aljadria street, Baghdad ,Tel:7765180 E-Mail : cosqc@cosqc.gov.iq

Annex1/Results

Before adjustment

Load (g)	Reading(g)	Error (g)
0.1	0.094	-0.006
200	199.968	-0.032
2000	1999.965	-0.035
7000	6999.931	-0.069
10100	10100.015	0.015

After adjustment

1-Weighing Performance:

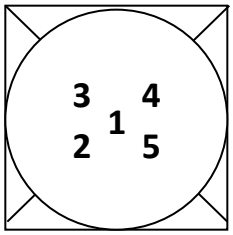
Load (g)	Increasing Load		Load (g)	Decreasing Load	
	Reading(g)	Error (g)		Reading(g)	Error (g)
0.1	0.094	-0.006	10100	10100.015	0.015
200	199.968	-0.032	7000	6999.931	-0.069
2000	1999.965	-0.035	2000	1999.965	-0.035
7000	6999.931	-0.069	200	199.968	-0.032
10100	10100.015	0.015	0.1	0.094	-0.006

2-Repeatability Test:

Load(g)	Reading(g)					
100%Max	10000.031	10000.007	9999.996	9999.987	10000.011	10000.022
50%Max	4999.978	4999.994	4999.971	4999.981	4999.968	4999.989

3-Eccentricity Test: **(Difference from center)**

Position No.	1	2	3	4	5
Load(g)	2500				
Reading (g)	2499.972	2499.979	2499.962	2499.959	2499.981
Error (g)	----	0.007	-0.010	-0.013	0.009



4-TheExpanded Uncertainty:

load(g)	Expanded Uncertainty ±(g)
10000	0.031
5000	0.013

Table 2.20: The date that taken from electronic weighing instrument and mass that used to calibration it from latest certificate of mass.

	Half Max	Max
Range (g)	**5000**	**10000**
U expanded	**1.170**	**3.408**
Tolerance (OIML)	**8**	**50**
Resolution	**0.001**	**0.001**

Note: When d is division or Resolution

Temp. : (18.08 ºC) **R. H.: (36.4 %)** **Pressure: (1008.04 mbar)**

Table 2.21: Reading 5 different value of weights that cover all range of electronic weighing instrument.

Load (g)	Increasing Load	
	Reading(g)	Error (g)
0.1	0.094	-0.006
200	199.968	-0.032
2000	1999.965	-0.035
7000	6999.931	-0.069
10100	10100.015	0.015

Table 2.22: Repeatability test

Load(g)	Reading(g)					
100%Max	10000.031	10000.007	9999.996	9999.987	10000.011	10000.022
50%Max	4999.978	4999.994	4999.971	4999.981	4999.968	4999.989

Table 2.23: The Expanded Uncertainty of electronic weighing instrument

load(g)	Expanded Uncertainty ±(g)
10000	0.031
5000	0.013

2.2.2.3 Second Experiment without air current:

Electronic weighing instrument it max range is 10100 g and division is 0.001 g (1 mg) and was without air current and temperature was 26.01 as shown in calibration certificate of this experiment below:

(FOR-TC-012-1)

Calibration certificate

Central Organization for Standardization and Quality Control (COSQC)

Metrology Department / Mass & Pressure section / Mass Lab.

P.O. Box13032 Aljadria street, Baghdad ,Tel:7765180 E-Mail : cosqc@cosqc.gov.iq

Accredited Lab — Accreditation no. CL 003

Certificate No: MAS/ - /2021

Date of issue : 2 / 11 /2021

Customer	
Name:	الجهاز المركزي للتقييس و السيطرة النوعية / قسم المقاييس
Address:	بغداد

Item under calibration

Description:	**Electronic Weighing Instrument**				
Manufacturer:	**Mettler Toledo**				
Model:	**XPE 1003SC**				
Serial number:	**B610195897**				
Other identification:	**Max: 10100 g**	**Class I**	**d= 0.001 g**	**e= 0.001 g**	**min: 0.1g**
Date of reception:	**/**	**Order No.: /**			
Condition of reception:	**As Found**				

Standard(s) used in the calibration

Description:	**Set of weights (1mg – 100g)**	**Set of weights (100g – 5 kg)**	**Single weight (10 kg)**
Manufacturer:	**Oertling**	**Oertling**	**Mettler Toledo**
Model:	**/**	**/**	**/**
Serial number:	**801532**	**801530**	**B 249588670**
Other identification:	**W 12**	**W 10**	**W 33**

Calibration information

Date of calibration:	**31 / 10 / 2021**
Place of calibration:	مختبر الكتلة
Method(s) of calibration:	**Calibration method using a set of mass Accuracy Class (E2 AND F1) Base down on OIML R76-1:2006**
Calibrated quantity:	**Mass**
Results of calibration:	**Attached a complete result in Annex 1 of this certificate**
Measurement uncertainty:	**The reported expanded uncertainty is based on Guide JCGM 100:2008 and EA cg NO.18V4.0(11/2015) Standard Uncertainty multiplied by coverage factor k=2 to give confidence level of 95%. The uncertainty doesn't include the eccentricity or hysterics errors. The end user shall estimate both eccentricity and hysterics according to real measurement procedure.**
Metrological traceability:	**The traceability of measurement results to the SI units is issued by the National standard maintained at Central Organization for standardization and Quality Control through Calibration certificate issued from PTB:(W41,W42,W44,W45,W46)**
Environmental conditions of calibration:	**Temp. : (26.01 ºC) R. H. : (37.3 %) Pressure: (1008.04 mbar)**
Observations, opinions or Recommendations:	**The results are within the tolerance of OIML R76-1**

Ref:PROC-TC-012

Calibration certificate (FOR-TC-012-1)
Central Organization for Standardization and Quality Control (COSQC)
Metrology Department/Mass & pressure section/Mass Lab.
P.O. Box13032 Aljadria street, Baghdad ,Tel:7765180 E-Mail : cosqc@cosqc.gov.iq

Annex1/Results

Before adjustment

Load (g)	Reading(g)	Error (g)
0.1	0.100	0.000
200	200.001	0.001
2000	2000.006	0.006
7000	7000.031	0.031
10100	10100.056	0.056

After adjustment

1-Weighing Performance:

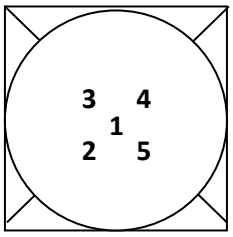
Load (g)	Increasing Load		Load (g)	Decreasing Load	
	Reading(g)	Error (g)		Reading(g)	Error (g)
0.1	0.100	0.000	10100	10100.056	0.056
200	200.001	0.001	7000	7000.031	0.031
2000	2000.006	0.006	2000	2000.006	0.006
7000	7000.031	0.031	200	200.001	0.001
10100	10100.056	0.056	0.1	0.100	0.000

2-Repeatability Test:

Load(g)	Reading(g)					
100%Max	10000.055	10000.054	10000.054	10000.054	10000.054	10000.054
50%Max	5000.027	5000.026	5000.027	5000.027	5000.027	5000.027

3-Eccentricity Test: **(Difference from center)**

Position No.	1	2	3	4	5
Load(g)	2500				
Reading (g)	2500.002	2500.001	2500.002	2500.001	2500.000
Error (g)	----	-0.001	0.000	-0.001	-0.002



4-TheExpanded Uncertainty:

load(g)	Expanded Uncertainty ±(g)
10000	0.028
5000	0.011

Table 2.24: The date that taken from electronic weighing instrument and mass that used to calibration it from latest certificate of mass.

	Half Max	Max
Range (g)	**5000**	**10000**
U expanded	**1.170**	**3.408**
Tolerance (OIML)	**8**	**50**
Resolution	**0.001**	**0.001**

Note: When d is division or Resolution

Temp. : (26.01 ºC) **R. H.: (37.3 %)** **Pressure: (1008.04 mbar)**

Table 2.25: Reading five different value of weights that cover all range of electronic weighing instrument.

Load (g)	Increasing Load	
	Reading(g)	Error (g)
0.1	0.100	0.000
200	200.001	0.001
2000	2000.006	0.006
7000	7000.031	0.031
10100	10100.056	0.056

Table 2.26: Repeatability test

Load(g)	Reading(g)					
100%Max	10000.055	10000.054	10000.054	10000.054	10000.054	10000.054
50%Max	5000.027	5000.026	5000.027	5000.027	5000.027	5000.027

Table 2.27: The Expanded Uncertainty of electronic weighing instrument

load(g)	Expanded Uncertainty ±(mg)
10000	0.028
5000	0.011

2.2.2.4 Comparing between the results of three different cases

Table 2.28: Comparing between the results of three different cases for five weights

Load (g)	without air current Temperature (18.37)		with air current Temperature (18.08)		without air current Temperature (26.01)	
	Reading(g)	Error (g)	Reading(g)	Error (g)	Reading(g)	Error (g)
0.1	0.100	0.000	0.094	-0.006	0.100	0.000
200	200.001	0.001	199.968	-0.032	200.001	0.001
2000	2000.003	0.003	1999.965	-0.035	2000.006	0.006
7000	7000.026	0.026	6999.931	-0.069	7000.031	0.031
10100	10100.060	0.060	10100.015	0.015	10100.056	0.056

We noticed the results of three different cases for five measure weights of electronic weighing instrument of cases without air current almost not change reading even with different temperatures and observed change with air current.

Table 2.29: Comparing between the results of three different cases for max and half of Repeatability test

Load(g)	**Reading(g) without air current and the Temperature is (18.37)**					
100%Max	10000.058	10000.058	10000.058	10000.057	10000.057	10000.057
50%Max	5000.015	5000.016	5000.016	5000.016	5000.016	5000.016
Load(g)	**Reading(g) without air current and the Temperature is (18.08)**					
100%Max	10000.031	10000.007	9999.996	9999.987	10000.011	10000.022
50%Max	4999.978	4999.994	4999.971	4999.981	4999.968	4999.989
Load(g)	**Reading(g) without air current and the Temperature is (26.01)**					
100%Max	10000.055	10000.054	10000.054	10000.054	10000.054	10000.054
50%Max	5000.027	5000.026	5000.027	5000.027	5000.027	5000.027

We noticed the repeatability of cases without air current almost not change reading even with different temperatures and observed change with air current.

Table 2.30: Comparing between the results of three different cases of Expanded Uncertainty of electronic weighing instrument

load(g)	**Expanded Uncertainty ±(g) without air current Temperature (18.37)**	**Expanded Uncertainty ±(g) without air current Temperature (18.08)**	**Expanded Uncertainty ±(g) without air current Temperature (26.01)**
10000	0.028	0.031	0.028
5000	0.011	0.013	0.011

We noticed the expanded uncertainty of cases without air current almost not change reading even with different temperatures and observed change with air current.

2.3 Discussion

Two different electronic weighing instruments was used in two experiments of this study. The range of these electronic weighing instruments are 510 g and 10100 g. we used max and half range in these first experiment are 500 g and 200 g, and have resolution equal 0.0001g (0.1mg) .We noticed the expanded uncertainty of cases without air current almost not change reading even with different temperatures and observed change with air current as shown in table 2.15. While, we noticed the repeatability of cases without air current almost not change reading even with different temperatures and observed change with air current as shown in table 2.14. Also, we noticed the results of three different cases for five measure weights of electronic weighing instrument of cases without air current almost not change reading even with different temperatures and observed change with air current as shown in table 2.13.

We used max and half range in these second experiment are 10000 g and 5000 g, and have resolution equal 0.001g (1mg). We noticed the expanded uncertainty of cases without air current almost not change reading even with different temperatures and observed change with air current as shown in table 2.30. While, we noticed the repeatability of cases without air current almost not change reading even with different temperatures and observed change with air current as shown in table 2.29. Also, we noticed the results of three different cases for five measure weights of electronic weighing instrument of cases without air current almost not change reading even with different temperatures and observed change with air current as shown in table 2.28.

Chapter Three

Conclusions and Recommendations

3.1 Conclusion

1. The air current is most effective over the expanded uncertainty and repeatability uncertainty and calibration electronic weighing instruments.
2. The temperature is less effective over the expanded uncertainty and repeatability uncertainty and calibration electronic weighing instruments.
3. Expanded uncertainty get more increasing when it reads unstable into repeatability test.
4. According to ISO/IEC 17025/2017 the uncertainty in calibration is most effective in calibration result than for test.

3.2 Recommendations

1. Through this study it has been observed the air currents changing the measures and Repeatability and it is affected on expanded uncertainty, so we suggest to shut down the air conditioner (AC) and close doors and windows while calibration the electronic weighing instruments.
2. Commitment to temperatures for each class of electronic weighing instruments as International Standard (OIML-R76:2006) as shown in chapter 1 (1.7).
3. Should putting the electronic weighing instruments into chambers for making more isolated of air current.

Ministry of planning
Central organization for standardization and quality control
Meteorology department
Mass & pressure section

The environmental conditions of calibration and it effect on reading stability of electronic weighing instruments into the laboratory of mass

Prepared by

Ahmed Alaa Ihsan & **Saif Ali Saadi**
MS.C. physics MS.C. Physics

2021

Reference

[1] EURAMET Calibration Guide No. 18 “Guidelines on the Calibration of Non-Automatic Weighing Instruments” Version 4.0 (10/2015).

[2] OIML R76-1 “Non-automatic weighing instruments Part 1: Metrological and technical requirements”, (2006), Tests

[3] DIRECTIVE 2009/23/EC, “Non-automatic weighing instruments”, (2009)

[4] International Recommendation Nº111 “Weights of classes E1, E2, F1, F2, M1, M2, M3”, ch. 6, pp. 70-74.

[5] International Recommendation OIML R76 -1 “Nonautomatic weighing instruments”, (2006), Annex A. pp 68-73

[6] ISO Budgets LLC, “Sources of Uncertainty in Measurement for Every Uncertainty Budget”, Rick Hogan, (2015).

[7] Document 2089, Edition 00 “Specific requirements relating to the calibration of nonautomatic weighing instruments”, (October 2000) ch.8.5 - 8.6, pp 19-24.

[8] XVIII IMEKO WORLD CONGRESS Metrology for a Sustainable Development, “Calibration of nonautomatic weighing instruments”, Adriana Vâlcu, (January 2007)