معهد الإمارات للمترولوجيا
Emirates Metrology Institute

مجلس أبوظبي للجودة والمطابقة
ABU DHABI QUALITY AND CONFORMITY COUNCIL

# Emirates Metrology Institute

## The National Metrology Institute of The United Arab Emirates

## ANNUAL REPORT 2015


H.H. Sheikh Khalifa Bin Zayed Al Nahyan
The President Of United Arab Emirates

**H.H. Sheikh Mohammed Bin Zayed Al Nahyan**
Crown Prince of Abu Dhabi
Deputy Supreme Commander of UAE Armed Forces

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## 1. Foreword

بسم الله الرحمن الرحيم

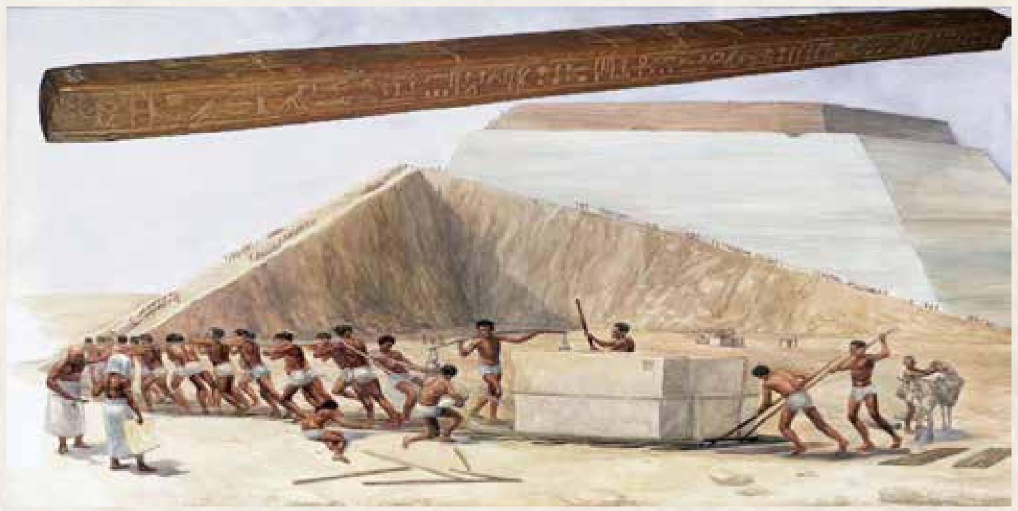
وَإِلَى مَدْيَنَ أَخَاهُمْ شُعَيْبًا قَالَ يَا قَوْمِ اعْبُدُوا اللَّهَ مَا لَكُم مِّنْ إِلَٰهٍ غَيْرُهُ وَلَا تَنقُصُوا الْمِكْيَالَ وَالْمِيزَانَ إِنِّي أَرَاكُم بِخَيْرٍ وَإِنِّي أَخَافُ عَلَيْكُمْ عَذَابَ يَوْمٍ مُّحِيطٍ (84) وَيَا قَوْمِ أَوْفُوا الْمِكْيَالَ وَالْمِيزَانَ بِالْقِسْطِ وَلَا تَبْخَسُوا النَّاسَ أَشْيَاءَهُمْ وَلَا تَعْثَوْا فِي الْأَرْضِ مُفْسِدِينَ (85)

And to Madyan (We sent) their brother Shu'aib. He said: O my people! Serve Allah, you have no God other than He, and do not give short measure and weight: surely I see you in prosperity and surely I fear for you the punishment of an all-encompassing day. (84) And, O my people! give full measure and weight fairly, and defraud not men their things, and do not act corruptly in the land, making mischief. (85)

كما أَخْبَرَنَا أَحْمَدُ بْنُ سُلَيْمَانَ، قَالَ حَدَّثَنَا أَبُو نُعَيْمٍ، قَالَ حَدَّثَنَا سُفْيَانُ، عَنْ حَنْظَلَةَ، عَنْ طَاوُسٍ، عَنِ ابْنِ عُمَرَ، عَنِ النَّبِيِّ (صلى الله عليه وسلم) قَالَ: الْمِكْيَالُ مِكْيَالُ أَهْلِ الْمَدِينَةِ وَالْوَزْنُ وَزْنُ أَهْلِ مَكَّةَ.

It was narrated from Ibn 'Umar that the Prophet (PBUH) said:
"The measure (to be used) is the measure of the people of Al-Madinah, and the weight (to be used) is the weight of the people of Makkah."

The death penalty faced those who forgot, or neglected, their duty to calibrate the standard unit of length at each full moon. Such was the peril courted by the royal site architects responsible for building the temples and pyramids of the Pharaohs in ancient Egypt, 3000 years BC. The first royal cubit was defined as the length of the forearm from elbow to tip of the extended middle finger of the ruling Pharaoh, plus the width of his hand. The original measurement was transferred to and carved in black granite. The workers at the building sites were given copies in granite or wood and it was the responsibility of the architects to maintain them.



FOREWORD

## 2. Introduction

The UAE Vision 2021 aims to make the UAE among the best countries in the world by the Golden Jubilee of the Union. In order to translate the vision into reality, its pillars have been mapped into six national priorities which represent the key focus sectors of government action in the coming years. The Emirates Metrology Institute (EMI) contributes to the UAE Vision 2021 objectives by establishing world class metrology.

Abu Dhabi's Economic Vision 2030 identified two key priority areas for economic development in Abu Dhabi; building a diversified, sustainable economy, and ensuring a balanced social and regional economic development approach that brings benefits to all. Among the many strategic initiatives the government has taken the establishment of a government entity to further develop and improve the national quality infrastructure so that it is comparable to the quality infrastructure of advanced and developed economies.

Under the patronage of HH Sheikh Hamed bin Zayed Al Nahyan, Chairman of the Crown Prince Court, the realization of this vision began with the establishment of the Abu Dhabi Quality and Conformity Council (QCC) as a standalone entity, under Law #3/2009. QCC is addressing the challenges and leading Abu Dhabi's efforts towards embedding quality into local culture, and integrating the Emirate into the international Quality Infrastructure (QI) framework.

Under a visionary QCC leadership, EMI took all necessary initiatives and actions to become the National Reference in Measurements and accordingly, in December 2014, the board of directors of Emirates Standardization and Metrology Authority (ESMA) nominated the EMI as the National Metrology Institute of UAE, with responsibility for the following:

- Maintain the national measurement standards.
- Sign the MRA agreement with the International Bureau of Weights and Measures and to facilitate international recognition of the UAE metrology system.
- Disseminate the units, providing traceability to the national references for other elements of the metrology system.
- Represent the UAE internationally in organizations and events related to metrology.
- Provide the necessary advice and support to the government, industry, commerce and the public on metrological issues.





## 3. Executive Director Message

The onset of the global industrial revolution in the late 19th Century created a demand for measurement standards having ever increasing accuracies, and also the need to demonstrate equivalence of the national measurement standards of different countries. As a result, the Convention of the Metre - a treaty that created the International Bureau of Weights and Measures (BIPM) - was signed in Paris by representatives of 17 nations on 20 May, 1875.

Since the founding of the UAE in 1971, the main concern of our Late Father, Sheikh Zayed Bin Sultan Al Nahyan, was how best to increase the quality of life for his citizens, as well as those who lived on UAE soil, indeed making them the happiest people in the world.

During the past decade, under the leadership of H.H. Sheikh Khalifa Bin Zayed Al Nahyan, the UAE will become one of the best countries in the world by the year 2021.

Scientific development is the key element to the success of any nation and, under the auspices of the Abu Dhabi Quality and Conformity Council, the Emirates Metrology Institute (EMI) was established in 2013, and is considered to be one of the best contributors to achieving the UAE Vision 2021.

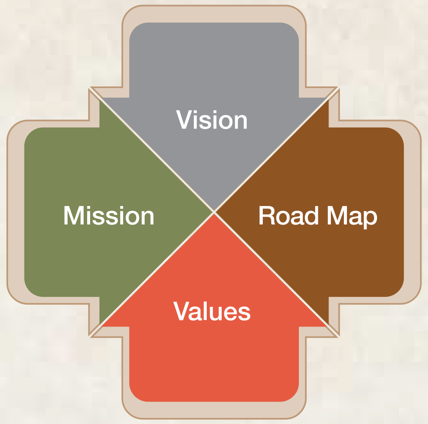
EMI is dedicated to achieving this success by following an ambitious roadmap for the future with a well-defined EMI vision and mission. The EMI management has attracted technical experts, in different fields of metrology, from National Metrology Institutes (NMIs) all over the world to assure knowledge transfer to young Emirati metrologists. With this combination of human resources, and state-of-the-art equipment and reference standards, EMI has become the top ranking NMI in the region.

The feasibility study for the second phase of the EMI development, conducted in the first quarter of this year, showed that this newly established NMI is expected to yield a direct benefit to the UAE economy, in various sectors, totaling more than AED 6 billion by 2024.

Our journey to excellence never ends, and achieving current vision will take us to another uphill journey, we believe in our capabilities and always have solutions to any challenges and obstacles.

**Dr. Helal Humaid Al Kaabi**
Executive Director

# 4. EMI Vision, Mission, Values and Road Map



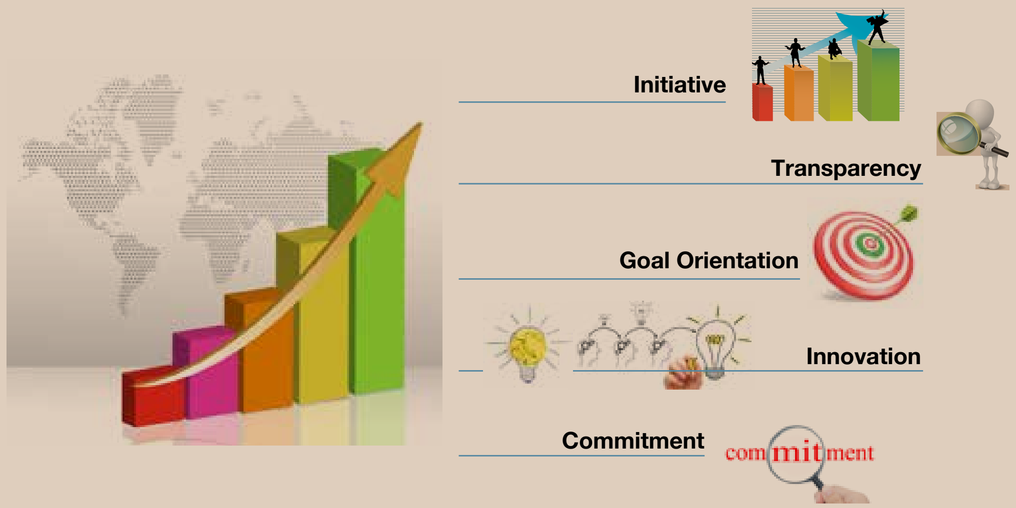

### VISION

To be the national and regional reference in measurements

### MISSION

To provide its stakeholders with internationally recognized reference measurements, with the degree of accuracy required to support the objectives set out in “UAE Vision 2021” and “Abu Dhabi 2030 Economic Vision”

### QCC VALUES

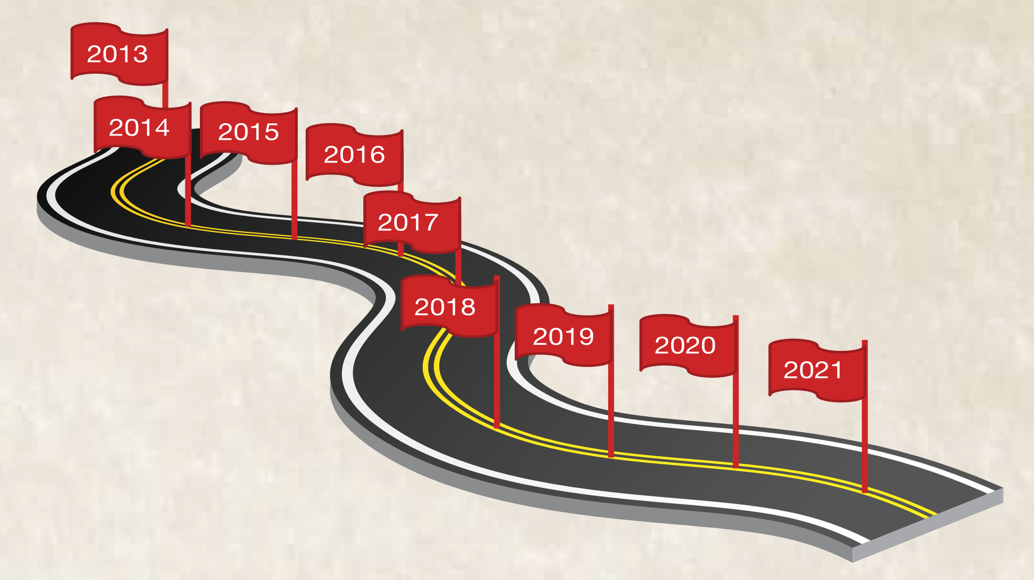






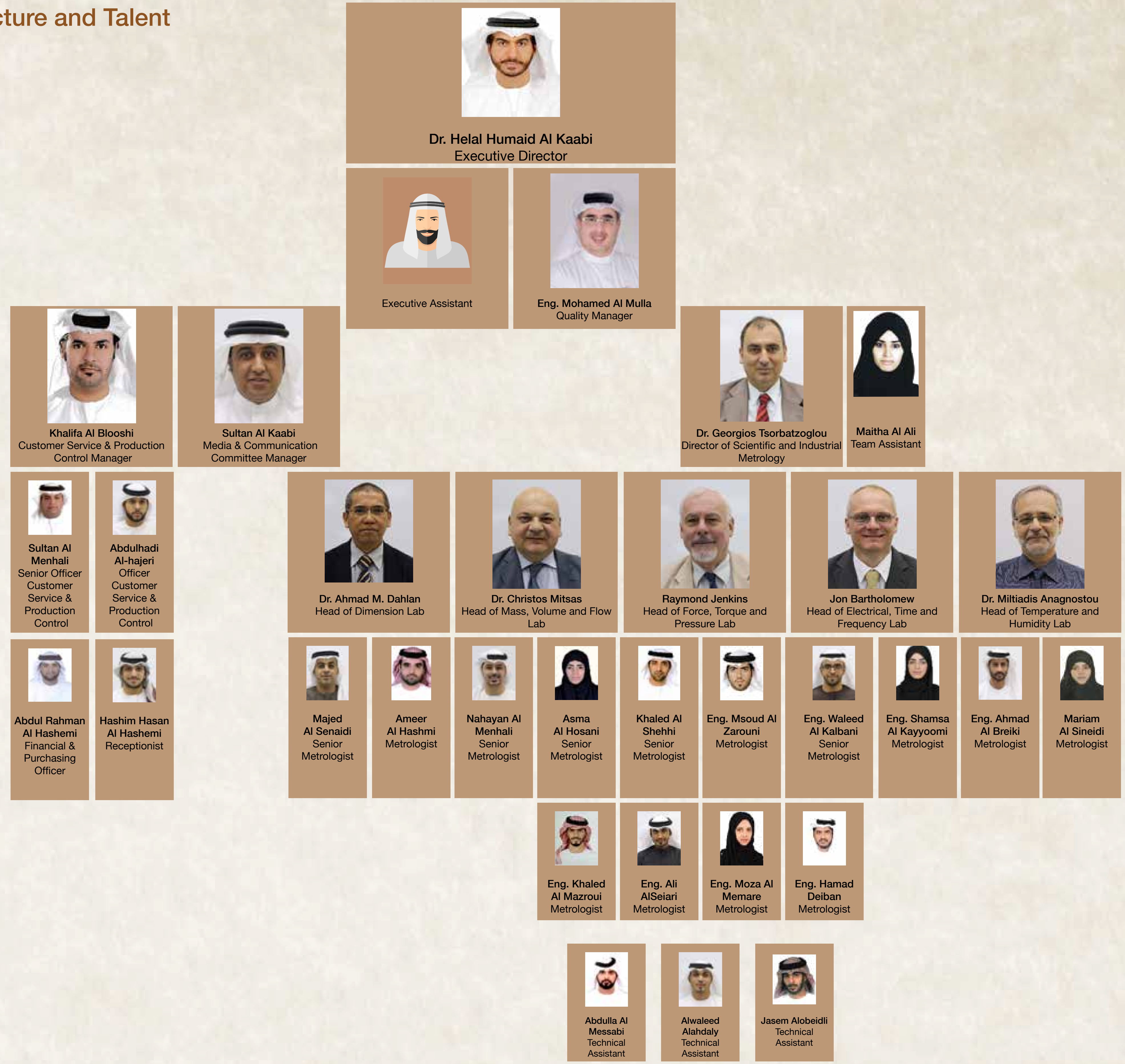

EMI VISION, MISSION, VALUES AND ROAD MAP

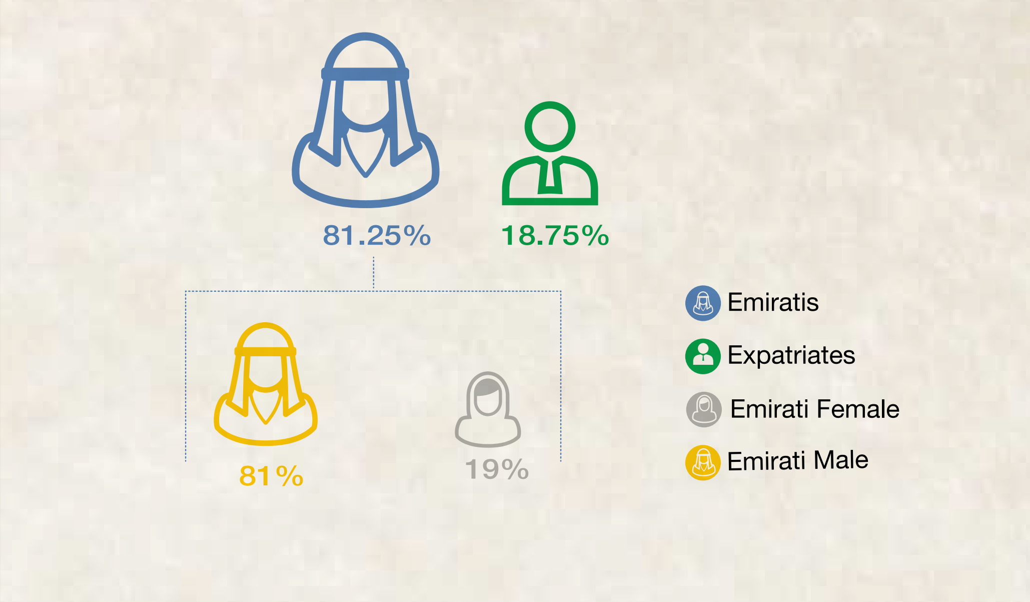
## Road Map




| Establishment & building capabilities | Phase 2 & Further development of capabilities | Strengthening EMI position at an International level |
|---|---|---|
| 1. Defining and reviewing policies for the operation of the EMI<br>2. Finding and Fit-out of temporary building<br>3. Procuring measuring and other supporting equipment<br>4. Hiring competent experts and national talents<br>5. Finding and obtaining ownership of the land for permanent building<br>6. Drafting and implementing the Quality Management System (QMS)<br>7. Accreditation of 25 calibration services to ISO/IEC 17025 | 1. Providing evidence of competence<br>2. Nomination by ESMA as the NMI of UAE<br>3. Accreditation of new services<br>4. Building trust of local stakeholders & international cooperations<br>5. Next Phase-Establishing permanent facilities for EMI as a National Metrology Institute | 1. To make EMI a center of research for measurements<br>2. To become a well-known NMI |

## 5. EMI Structure and Talent






## 6. EMI Laboratories

The EMI provides calibration services that ensure accurate and internationally compatible measurements covering the UAE's economy and industry needs. Further details of calibration services and the technical capabilities of the individual laboratories are provided in the following sections.







### 6.1 Mass, Volume and Flow Laboratories

The laboratory realizes the unit of mass through an ensemble of three stainless steel primary 1 kg mass standards providing traceability to the International Prototype Kilogram (IPK) through the German and Austrian national standards. The traceability of sub-multiples and multiples of the kilograms in the range 1 mg – 500 kg is ensured through calibration by implementing appropriate weighing designs. Calibrations of mass standards in terms of conventional and true mass and AWI's (balances) are offered as follows:

| Artifact / Instrument | Range | CMC |
|---|---|---|
| Mass standards | 1 mg…500 mg | 1000…5 ppm |
| | 1 g…50 g | 3…0.2 ppm |
| | 100 g…10 kg | 0.16 ppm |
| | 20 kg…50 kg | 0.5…1.6 ppm |
| | 100 kg…500 kg | 14…34 ppm |
| NAWI's | 200 mg…5 kg | 50…0.8 ppm |
| | 10 kg…170 kg | 2.5…5 ppm |

Liquid Flow is realized through a primary volumetric standard (piston prover), which covers the range from 0.4 to 1,400 LPM or through the master meter method up to 2,000 LPM. The calibration liquid used is a water +2% propylene glycol mixture. Traceability is to the US national standards (NIST).

Calibrations of different types of liquid flow meters (turbine, coriolis, positive displacement, e-mag) with sizes from 3/8”…2” (AN-6…AN-32) are carried out at ambient conditions as follows:

- Volume flow in the ranges 24…84,000 L/h and 36…114,000 L/h with relative expanded uncertainties 0.12% and 0.20%, respectively.
- Mass flow rate can be determined through measurement of the density of the liquid used covering the range 25 to 85,000 kg/h with relative expanded uncertainty 0.15%.

Gas Flow is realized through primary volumetric reference devices of the piston and bell prover type operating with compressed air up to 8 bar at ambient conditions. Measurement traceability is to the US national standards (NIST). Calibrations of different types of gas flow or volume meters (rotary, turbine, etc.) with sizes from 1/4”…1” (AN-4…AN-16) are carried out in the following measuring ranges:

- 5…50,000 sccm and 14…1,400 LPM with relative uncertainty (k=2) 0.2% and 0.22% respectively.







The laboratory employs gravimetric and volumetric methods for the calibration of piston operated volumetric instruments, volumetric glassware and metallic prover vessels. Measurement traceability is ensured through the UAE national standards of mass, density and temperature (EMI). Volume calibrations are offered as follows:

- Micro-pipettes, burettes, dispensers 10 µL…10 mL with uncertainties (k=2) 0.18…8.5=L.
- Flasks, cylinders, pipettes, burettes 1 mL…2000 mL with uncertainties (k=2) 0.01…1.5 mL.
- Prover vessels 5…100 L with relative uncertainty (k=2) 0.05%.
- Prover vessels 50…2000 L with relative uncertainty (k=2) better than 0.1%.
- Mass, Volume & Flow Laboratories have all been assessed by UKAS on 28-30 September, 2015, and all accepted to be accredited.

| Parameter | Range | CMC |
|---|---|---|
| Mass standards | 1 mg…500 kg | E1: 1 mg…10 kg |
| | | E2: 1 mg…20 kg |
| | | F1: 1 mg…50 kg |
| | | M1: 1 mg…500 kg |
| NAWIs | 20 mg…170 kg | E2 and F1 weights used |
| Volume | Micro pipettes: 100 µL…10 mL | 0.3 µL… 8 µL |
| | Glassware (flasks, cylinders, burettes, etc.): 100 mL – 2000 mL | 0.015 mL…1.5 mL |
| | Prover vessels: 5 L…50 L | 0.05 % |

## 6.2 Dimension and Angle Laboratory

The Dimension laboratory realizes the unit of length through two sets of frequency stabilized He-Ne lasers. These two lasers provide EMI with capability of measuring various artifacts either directly or indirectly as listed below.
According to ISO 3650, the reference grade gauge block (grade K) is calibrated by interferometry. With the frequency stabilized lasers coupled to a Twyman-Green interferometer designed by the National Physical Laboratory, United Kingdom, the laboratory is able to provide the following services:

| Gauge length | Material | Parameter | CMC |
|---|---|---|---|
| 0.5 mm to 300 mm | Steel Ceramics Tungsten Carbide | Central length deviation | $\sqrt{[(25)^2 + (0.65xL)^2]}$nm where L is in mm |

The interferometer is also used to calibrate other gauge blocks made of ceramics and tungsten carbides but with slightly lower uncertainties. The same interferometer is also used for measuring other end standards artifacts such as length bars and square gauge blocks (Hoke gauges).
Gauge blocks of lower grades (grade 0, 1 and 2) are calibrated by comparison with EMI reference gauge blocks. Using this method, the following service is available:

| Gauge length | Material | Parameter | CMC |
|---|---|---|---|
| 0.5 mm to 100 mm | Steel | Central length deviation | [0.09 + 0.8.L]µL where L is in metre |

### DIAMETER STANDARDS

Diameter standards such as plug and ring gauges (including GO and NO-GO) are calibrated by comparative measurement using reference gauge blocks or reference ring gauges as standards. In this category, the following services are provided by the laboratory:

| Artifacts | Range | Parameter | CMC |
|---|---|---|---|
| Internal diameter gauges | 15 mm to 50 mm | Diameter | [0.60+0.005 D] µm, where D is in mm |
| External diameter gauges | Up to 80 mm | Diameter | [0.65+0.005 D] µm where D is in mm |

### FORM

The following form parameters can be measured by the laboratory. The laboratory uses NPL designed gauge block interferometer:

| Artifacts | Parameters | CMC |
|---|---|---|
| Optical flats and parallels (maximum diameter 50 mm) | Flatness | 0.05 µm |

### ANGLE STANDARDS (SELFA ROTARY ENCODER)

| Artifacts | Range | Parameter | CMC |
|---|---|---|---|
| Polygon<br>Autocollimator<br>Angle gauges<br>Level meters<br>Angle encoder | 360º | Angle | 0.05 arcsec |

TEMPERATURE AND HUMIDITY LABORATORY

## 6.3 Temperature and Humidity Laboratory

The Temperature laboratory realizes the International Temperature Scale of 1990 (ITS-90) through a set of fixed point cells (TPW, Hg, Ga, In, Sn, Zn and Al) and a set of standard platinum resistance thermometers (SPRTs). Calibration services provided are:

### STANDARD PLATINUM RESISTANCE THERMOMETERS
Calibration of Standard Platinum Resistance Thermometers directly at the fixed points of TPW, Hg, Ga, In, Sn, Zn and Al, covering the temperature range from -38.8344 °C to 660.323 °C, with an expanded uncertainty of 0.7 mK to 4 mK.

### PLATINUM RESISTANCE THERMOMETERS
Calibration of Platinum Resistance Thermometers in comparison with SPRTs, using liquid baths to create uniform and stable temperature conditions, covering the range from -80 °C to 250 °C, with an expanded uncertainty of 0.01 °C to 0.02 °C.

### TEMPERATURE SENSORS WITH DISPLAY UNIT / LIQUID IN GLASS THERMOMETERS
Temperature sensors with display unit are calibrated in liquid baths and in block calibrators in comparison with reference thermometers. In liquid baths, the temperature range covered is from -80 °C to 250 °C, with an expanded uncertainty of 0.015 °C to 0.025 °C. Also in block calibrators, the temperature range covered is from 250 °C to 400 °C, with an expanded uncertainty of 0.6 °C to 0.8 °C. Liquid in glass thermometers are calibrated from -60 °C to 250 °C, with an expanded uncertainty of 0.02 °C to 0.05 °C

### TEMPERATURE BLOCK CALIBRATORS
Temperature block calibrators are calibrated using platinum resistance thermometers in the range from -30 °C to 400 °C, with an expanded uncertainty of 0.2 °C.

### LIQUID BATHS
Calibration of liquid baths is done between -80 °C to 250 °C, with an expanded uncertainty of 0.02 °C to 0.03 °C.

### CLIMATIC CHAMBERS AND FURNACES
Climatic chambers are calibrated in the range between -40 °C to 140 °C, with an expanded uncertainty of 0.2 °C. Temperature profile of the chamber can also be measured using 9 PRT sensors distributed in the working volume of the chamber. If the chamber has the capability to create relative humidity conditions, an additional reference hygrometer is used to measure these conditions. Furnaces can be calibrated in the range of 100 °C to 1100 °C, with an expanded uncertainty of 0.3 °C to 0.8 °C.





ELECTRICAL, TIME AND FREQUENCY LABORATORY

The Humidity Laboratory is using a two pressure generator to create reference relative humidity and air temperature conditions. Calibration services provided are:

### RELATIVE HUMIDITY SENSORS
Calibration of relative humidity sensors and data loggers in the range of 10 %rh to 95 %rh and air temperature between 10 °C and 70 °C. The expanded uncertainty of the measurement is 0.3 %rh to 0.8 %rh at 25 °C.

### AIR TEMPERATURE SENSORS
Calibration of air temperature sensors and data loggers in the range of 10 °C to 70 °C, in the chamber of the humidity generator, with an expanded uncertainty of 0.1 °C.

## 6.4 Electrical, Time and Frequency Laboratory

### TIME

The Laboratory realizes the unit of time through a group of cesium clocks which is aligned with the international time scale, Coordinated Universal Time (UTC), through regular time comparisons with a global network of national time standard laboratories, using the Global Positioning System (GPS).

Local frequency standards in the range 1 MHz to 30 MHz can be calibrated with a relative expanded uncertainty of 2.6 parts in $10^{12}$.

Frequency Counters in the range of 100 Hz to 350 MHz can be calibrated with relative expanded uncertainties of 3 parts in $10^{12}$ to 3 parts in $10^{10}$.
Stopwatches and clocks can be calibrated with expanded uncertainties of less than 1 second in 24 hours.

### RESISTANCE

Standard resistors from 100 mΩ to 1 GΩ are calibrated using a primary resistance bridge based on the values of groups of resistors at 1Ω, 10 kΩ and 100 MΩ. Current shunts can be calibrated at currents of up to 150 A.

| Range | CMC |
|---|---|
| 100 mΩ to 10 kΩ | 0.5 ppm |
| 100 kΩ to 1 MΩ | 3 to 6 ppm |
| 10 MΩ to 100 MΩ | 10 to 20 ppm |
| 1 GΩ | 200 ppm |

### VOLTAGE

Calibration is based on the value of a group of calibrated 10 V precision Zener references. Calibrations at other voltages are achieved using voltage dividers in the range from 1 mV to 1 kV.

| Range | CMC |
|---|---|
| 1 V to 10 V | 3 to 6 ppm |

The Laboratory also calibrates digital multi meters with resolutions of up to 6½ digits.







## 6.5 Force, Torque and Pressure Laboratories

### FORCE

The laboratory has a 5 MN hydraulic force standard machine for the calibration of force measuring devices in both compression and tension, either with increasing forces only, or with both increasing and decreasing forces.

- The machine has a range of 50 kN to 5000 kN in both compression and tension.
- The force applied is measured by reference force transducers incorporated in the machine in series with the device being calibrated.
- Traceability is provided by the use of EMI force transfer standards that have been calibrated by National Metrology Institutes such as PTB in Germany and NPL in the UK.
- Calibrations can be made in accordance with ISO 376 for force-proving instruments - or with a procedure agreed with the customer.
- A wide range of force measuring devices can be calibrated, with mechanical or electrical indication. A measuring amplifier can be provided, if necessary, for use with strain-gauge transducers.
- Tension fittings are available for the standard metric thread sizes specified in ISO 376 and advice can be provided for the design of special fittings and for the calibration of special-purpose force measuring devices.

The laboratory also has a range of force transducers that can be used with an associated measuring amplifier to calibrate force machines on a customer's site, including materials testing machines. The transducers can also be used for Inter Laboratory Comparisons.

| Machine | | Range | CMC |
|---|---|---|---|
| Force Standard Machine | Compression | 50 kN to 5000 kN | 0.02 % to 0.05 % |
| | Tension | 50 kN to 5000 kN | 0.02 % to 0.05 % |
| Force Transducers | Compression | 50 N to 5000 kN | 0.1 % |
| | Tension | 50 kN to 2000 kN | 0.1 % |

## TORQUE

The laboratory has a 1000 N·m deadweight torque standard machine for the calibration of torque measuring devices. Torque can be applied in both the clockwise and anticlockwise directions, with increasing values only, or with both increasing and decreasing values.

- The machine has a range of 0.5 N·m to 1000 N·m in both the clockwise and anticlockwise directions.
- Traceability is achieved by using calibrated stainless steel masses applied to a lever of known length. The value of gravity at the location of the machine has also been accurately measured.
- Calibrations can be made in accordance with EURAMET guide cg-14 for static torque measuring devices - or with a procedure agreed with the customer.
- The torque standard machine has been adapted so that it can calibrate reference torque wrenches, as well as reference torque transducers. A measuring amplifier can be provided, if necessary, for use with strain-gauge transducers.
- Advice can be provided on the various calibration procedures related to torque measurements, and on the best method of mounting different types of transducer in the EMI torque standard machine.





The laboratory has a range of reference torque transducers and torque wrenches covering a range from 1 N·m to 1000 N·m. These can be used for Inter Laboratory Comparisons and for the verification of torque testing machines that are used to calibrate industrial torque wrenches.

| Machine | Range | CMC |
|---|---|---|
| Torque Standard Machine | 0.5 N·m to 1000 N·m | 0.01 % to 0.1 % |
| Torque Transducers | 1 N·m to 1000 N·m | 0.02 % to 0.2 % |
| Reference Torque Wrenches | 1 N·m to 1000 N·m | 0.05 % to 0.5 % |

## PRESSURE LABORATORY


The laboratory is equipped with deadweight piston gauge standards that provide a very good uncertainty for the measurement of gas and oil pressures, over a wide range of pressure, in both the absolute and gauge mode. A special pressure standard can also make accurate measurements of small gas and oil differential pressures in the presence of a high line pressure up to 20 MPa.

The local value of gravity has been measured in the laboratory, and the masses, piston gauges and environmental sensors of the reference standards have been calibrated by an external National Metrology Institute to provide the required traceability.
The laboratory also has a vacuum calibration system with a vacuum chamber that can be heated to 200 °C. Depending on the value, the absolute pressure is measured by Ionising, Spinning Rotor, or Capacitance reference vacuum gauges which have been calibrated by an external National Metrology Institute.

FORCE, TORQUE AND PRESSURE LABORATORY

FORCE, TORQUE AND PRESSURE LABORATORY

The calibration service provided by the Pressure Laboratory is summarised in the following table:

| Medium | Mode | Range | Relative Uncertainty (95 % confidence level) |
|---|---|---|---|
| Gas | Absolute | 0.01 mPa to 1 mPa<br>1 mPa to 1 Pa<br>1 Pa to 9 kPa<br>9 kPa to 14.1 MPa | 10 %<br>1 %<br>0.05 %<br>0.003 % to 0.008 % |
| Gas | Gauge | -91 kPa to 14 MPa | 0.003 % to 0.008 % |
| Gas | Differential | 0 kPa to 200 kPa | 0.004 % + 9 Pa |
| Oil | Absolute | 0.2 MPa to 500.1 MPa | 0.003 % to 0.008 % |
| Oil | Gauge | 0.1 MPa to 500 MPa | 0.003 % to 0.008 % |
| Oil | Differential | 0 kPa to 200 kPa | 0.004 % + 9 Pa |

A wide range of pressure measuring instruments can be calibrated at EMI, including:

- Piston Gauges (by cross float)
- Precision Pressure Transducers and Calibrators/Controllers
- Differential Pressure Transducers
- Vacuum Gauges (Ionising, Spinning Rotor, Capacitance and other types)

| Machine | | Range | CMC |
|---|---|---|---|
| Force Standard Machine | Compression | (50 -5000) kN | 0.02% - 0.05% |
| | Tension | (50 -5000) kN | 0.02% - 0.05% |
| Transducer | compression | 50 N – 5 MN | |
| | Tension | 2 MN | |





The calibration service provided by the pressure laboratory is summarised in the following table:

| Medium | Mode | Range | CMC |
|---|---|---|---|
| Gas | Absolute | 0.01 mPa to 1 mPa<br>1 mPa to 1 Pa<br>1 Pa to 9 kPa<br>9 kPa to 14.1 MPa | 10 %<br>1 %<br>0.05 %<br>0.003 % to 0.008 % |
| Gas | Gauge | -91 kPa to 14 MPa | 0.003 % to 0.008 % |
| Gas | Differential | 0 kPa to 200 kPa | 0.004 % + 9 Pa |
| Oil | Absolute | 0.2 MPa to 500.1 MPa | 0.003 % to 0.008 % |
| Oil | Gauge | 0.1 MPa to 500 MPa | 0.003 % to 0.008 % |
| Oil | Differential | 0 kPa to 200 kPa | 0.004 % + 9 Pa |

A wide range of pressure measuring instruments can be calibrated at EMI, including:

- Piston gauges (by cross-float).
- Precision pressure transducer and calibrators/controllers.
- Differential pressure transducers.
- Vacuum gauges (ionising, spinning rotor, capacitance and other types).

FORCE, TORQUE AND PRESSURE LABORATORY

# 7. Building Capacity and Knowledge Transfer

## INTERNAL TRAINING

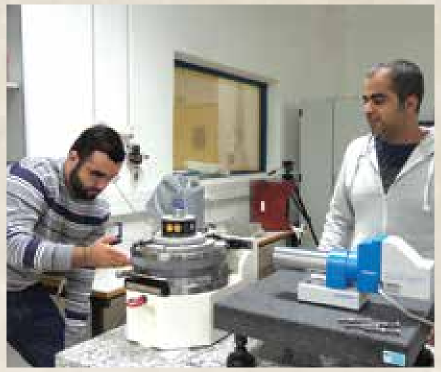
| Labs | Number of training | Training date | Talents/ Stake holders | Training subject | Talents involved |
|---|---|---|---|---|---|
| Force & Torque | 1 | 26 Oct to 28 Oct | Khaled AlShehhi<br>Msoud Al Zarouni<br>Alwaleed AlAhdaly<br>Moza Al Memare<br>Air Force | Force & torque measurements in general | Yes |
| Dimension | 2 | 17 Aug to 20 Aug<br><br>8 Dec to 10 Dec | Majed Al Senaidi<br>Ameer Al Hashmi<br>Air Force<br>Gulfmet | Dimensional measurements in general | Yes |
| Electrical Time & Frequency | 1 | 31 Aug to 2 Sep | Waleed Al Kalbani<br>Ahmed Al Breiki<br>Air Force<br>Etihad | Electrical Metrology | Yes |
| Mass & Flow | 2 | 15 June to 18 June<br><br>7 Dec to 10 Dec | Asma Al Hosani<br>Nahayan Al Menhali<br>Khaled Al Mazroui<br>Air Force | Instrumentation Errors & Uncertainty<br><br>Liquid flow & flow meter calibration | Yes |

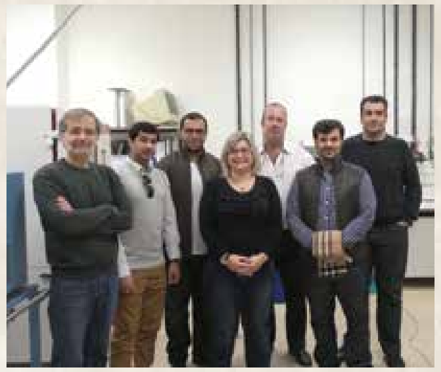




BUILDING CAPACITY AND KNOWLEDGE TRANSFER

## EXTERNAL TRAINING



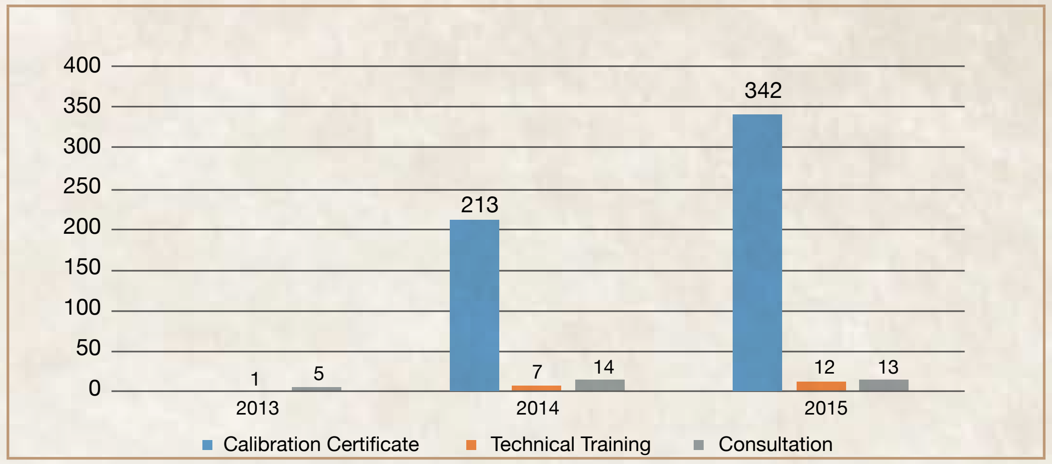


| Organization/Country | Date/Duration | Participants |
|---|---|---|
| **CMI/Czech Republic** | 17-21 June2013/5 days | Majed Al Senaidi<br>Waleed Al Kalbani<br>Nahayan Al Menhali<br>Asma Al Hosani<br>Khaled Al Shehhi<br>Msoud Al Zarouni<br>Dr. Helal Al Kaabi<br>Dr. Christos Mitsas |
| | 16-20 Sept 2013/5 days | Majed Al Senaidi<br>Waleed Al Kalbani<br>Ahmed Albreiki<br>Msoud Al Zarouni |
| **EIM/Greece** | 1-5 July 2013/5 days | Majed Al Senaidi<br>Waleed Al Kalbani<br>Nahayan Al Menhali<br>Asma Al Hosani<br>Khaled Al Shehhi<br>Msoud Al Zarouni<br>Dr. Christos Mitsas |
| | 9-13 Sept 2013/5 days | Majed Al Senaidi<br>Waleed Al Kalbani<br>Ahmed Albreiki<br>Khaled Al Shehhi |
| | 4-15 Nov 2013/10 days | Majed Al Senaidi<br>Waleed Al Kalbani<br>Nahayan Al Menhali<br>Asma Al Hosani<br>Khaled Al Shehhi<br>Msoud Al Zarouni<br>Ahmed Albreiki<br>Ameer Al Hashmi |
| | 20-31 Jan 2014/10 days | Majed Al Senaidi<br>Waleed Al Kalbani<br>Ahmed Albreiki |
| **SIRIM/Malaysia** | 30 Sept.-11 Oct 2013/10 days | Majed Al Senaidi<br>Waleed Al Kalbani<br>Nahayan Al Menhali<br>Asma Al Hosani<br>Khaled Al Shehhi<br>Msoud Al Zarouni<br>Ahmed Albreiki<br>Ameer Al Hashmi<br>Dr. Ahmad bin Dahlan |
| | 24-28 Nov. 2014/5 days | Ahmed Albreiki |

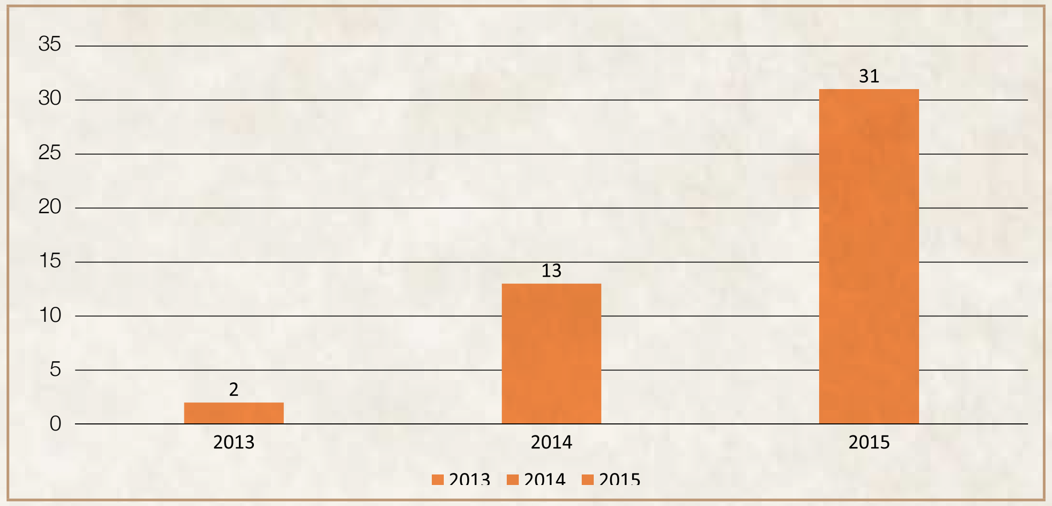


| Organization/Country | Date/Duration | Participants |
|---|---|---|
| **Fluke/Netherland** | 27-31/Jan. 2014/5 days | Raymond Jenkins<br>Khaled Al Shehhi<br>Msoud Al Zarouni |
| | 13-17 Jan. 2014/ 5 days | Dr. Ahmad bin Dahlan<br>Ahmed Albreiki |
| **KRISS/S. Korea** | 7-18 April 2014/12 days | Majed Al Senaidi<br>Ameer Al Hashmi |
| | 9-20 June 2014/12 days | Ahmed Albreiki |
| **NIST/USA** | 3-6 June 2014/4 days | Jon Bartholomew<br>Waleed Al Kalbani |
| **MAHR/GERMANY** | 10-13 Aug. 2014/4 days | Majed Al Senaidi<br>Ameer Al Hashmi |
| **NEL/UK** | 25-27 Nov. 2014/3 days | Nahayan Al Menhali<br>Asma Al Hosani |
| **Hexagon/UK** | 3-7 Nov. 2014/5 days | Dr. Ahmad bin Dahlan<br>Majed Al Senaidi<br>Ameer Al Hashmi |
| **VSL/Netherlands** | 19-22 Nov. 2013/4 days | Nahayan Al Menhali<br>Asma Al Hosani<br>Dr. Christos Mitsas |
| **UME/Turkey** | 8-12 Dec. 2014/5 days | Dr. Christos Mitsas<br>Nahyan Al Menhali |
| | 8-12 Dec. 2014/5 days | Jon Bartholomew<br>Waleed Al Kalbani |
| | 8-12 Dec. 2014/5 days | Ahmed Albreiki |
| **NPL/UK** | 2 - 6 Feb 2015/5 days | Raymond Jenkins<br>Khaled Al Shehhi<br>Msoud Al Zarouni |

## 8. EMI Services in Number




### NUMBER OF CUSTOMERS






## 9. EMI Quality Management System

The quality system of EMI is based on ISO/IEC 17025:2005, and accordingly in 2014, the EMI quality manual was prepared. Twenty-two quality procedures and numerous calibration procedures have been developed. At the beginning of 2015, EMI approached the United Kingdom Accreditation Service (UKAS) for accreditation of its various calibration services. An initial assessment was conducted by UKAS assessors in September and October 2015 to cover more than 25 different calibration services, and it is expected that accreditation will be granted to EMI by the 1st quarter of 2016.

EMI also implements Integrated Management System (IMS) in accordance with QCC policies which cover the ISO 9001:2008 quality management system, ISO 14001:2004 environmental management system and OHSAS 18001 occupational health and safety management system plus Business Continuity Management (BCM). EMI has also developed its own risk management policy and procedures to manage risk within its business plan and activities.

## 10. Bilateral and Inter Laboratory Comparison

The term "The Inter laboratory Comparison (ILC)" refers to any activity undertaken by NMIs to show their measurement capabilities and is a key input for publishing the CMCs of NMIs at BIPM Key Comparison Data Base and normally accreditation bodies ask for ILC results as an evidence for competency of calibration laboratories.

### MASS LABORATORY

BILATERAL COMPARISON BETWEEN EIM (GREECE) AND EMIRATES METROLOGY INSTITUTE (EMI/QCC) IN VOLUME CALIBRATION

GULFMET M.M.-S01: Multiples and sub-multiples of the kilogram 10 kg, 500 g, 20 g, 2 g, 100 mg Pilot:
UME (Turkey)

Table3. Calibration results

| Norminal Value | UME Mass Value mg | EMI/QCC Mass Value mg | UME Standard Uncertainty mg | EMI/QCC Standard Uncertainty mg | E-value |
|---|---|---|---|---|---|
| 10 kg | -6,8 | -6,6 | 0,75 | 0,97 | 0,16 |
| 500 g | 0,136 | 0,15 | 0,020 | 0,063 | 0,21 |
| 20 g | 0,002 | 0,003 | 0,0020 | 0,0050 | 0,19 |
| 2 g | 0,0010 | 0,0015 | 0,0017 | 0,0027 | 0,15 |
| 100 mg | 0,0020 | 0,0014 | 0,0010 | 0,0012 | 0,38 |

Successful performance: $E_n = \left|\frac{X_{Lab} - X_{Ref}}{\sqrt{U_{Lab}^{2} + U_{Ref}^{2}}}\right| \leq 1$

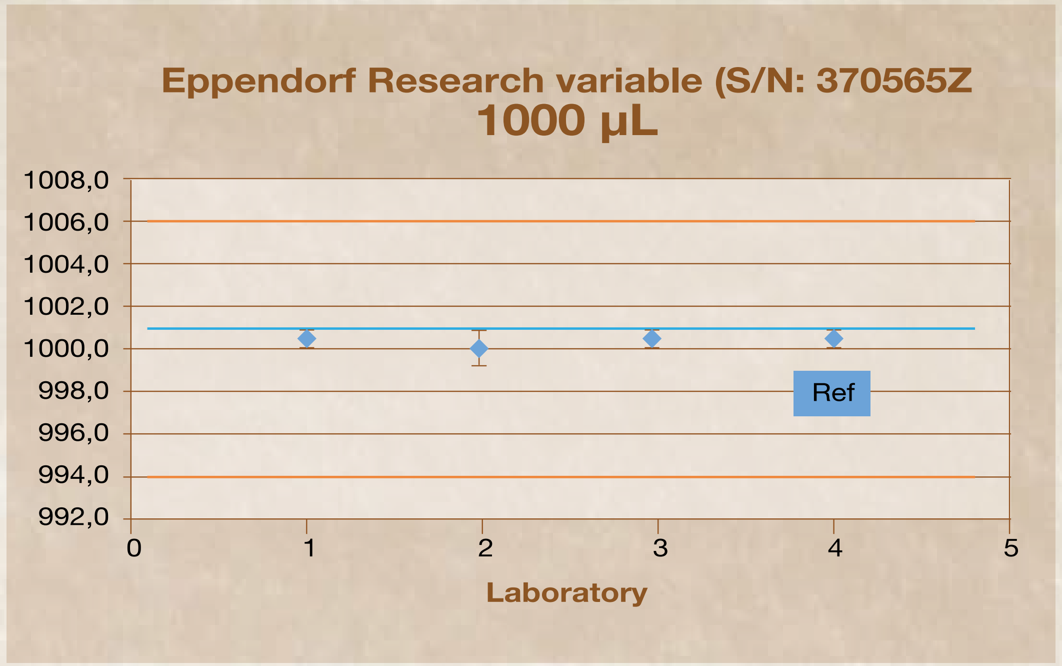
CALIBRATION OF A VARIABLE VOLUME 100 - 1000 µL micropipette

| Nominal volume (µL) | EIM | EMI/QCC | En |
|---|---|---|---|
| 1000 | 1000.58 ± 0.5 | 1000.000 ± 0.89 | 0.58 |
| 500 | 500.09 ± 0.41 | 499.57 ± 0.55 | 0.75 |
| 100 | 101.53 ± 0.26 | 102.38 ± 1.0 | 0.83 |










### ANTICIPATED WITHIN 2016:

- Mass: 1 kg stainless steel mass standard (GULFMET)
- Volume: One mark volumetric flask (bilateral APMP)
- Liquid Flow rate: Bilateral APMP

### DIMENSION AND ANGLE LABORATORY

**Analysis**

Summary of result is shown in Table 1 below:

| Nominal Value/ mm | Serial Number | EMI-QCC (LAB) | | NML-SIRM (REF) | | LAB-REF µm | \|En\| Value |
|---|---|---|---|---|---|---|---|
| | | Deviation /µm | $u_{Lab}$ @ k=1 | Deviation / µm | $u_{REF}$ @ k=1 | | |
| 1 | 400720 | 0.02 | 0.05 | 0.01 | 0.04 | 0.01 | 0.10 |
| 10 | 400647 | 0.01 | 0.05 | -0.07 | 0.04 | 0.08 | 0.62 |
| 50 | 400236 | 0.02 | 0.07 | -0.04 | 0.05 | 0.06 | 0.32 |
| 100 | 401005 | 0.08 | 0.10 | -0.06 | 0.06 | 0.14 | 0.59 |

The En value is calculated according to the following formula:

$$E_n = \frac{Lab - Ref}{\sqrt{(U^2_{Lab} + U^2_{Ref})}}$$

**Analysis**

Result of EMI measurement (average of before and after) was sent to NPL for a quick analysis. Summary of result is shown in the table below:

| S.No. | lenght/ mm | EMI result (Lab) | | NPL result (Ref) | | Diff | En k=2 |
|---|---|---|---|---|---|---|---|
| | | Deviation | Uncertainty (k=2) | Deviation | Uncertainty (k=2) | | |
| | | Lab/nm | $u_{Lab}$ /nm | Ref/nm/ | $u_{REF}$ /nm | | |
| 120547 | 2 | 65 | 25 | 82 | 20 | -17 | 0.50 |
| 110128 | 4 | 49 | 25 | 58 | 20 | -9 | 0.30 |
| 110607 | 6.5 | 119 | 25 | 135 | 20 | -17 | 0.50 |
| 120354 | 8 | 110 | 26 | 106 | 20 | 4 | 0.10 |
| 100859 | 10 | -77 | 26 | -75 | 20 | -1 | 0.00 |
| 111030 | 100 | -299 | 70 | -299 | 30 | 0 | 0.00 |

The En value is calculated according to the following formula:

$$E_n = \frac{Lab - Ref}{\sqrt{(U^2_{Lab} + U^2_{Ref})}}$$

## TORQUE LABORATORY

| N·m | EMI Ref. Values | EMI Uncertainty k=2 U2 | Norbar Values | | Norbar uncertainty k=2 U1 | En ratio |
|---|---|---|---|---|---|---|
| | mV/V | % | mV/V | % deviation | % | |
| 100 | -0.19987 | 0.0127 | -0.19988 | 0.006 | 0.025 | 0.20 |
| 200 | -0.39979 | 0.0156 | -0.39980 | 0.001 | 0.021 | 0.03 |
| 400 | -0.79974 | 0.0106 | -0.79971 | -0.004 | 0.021 | -0.16 |
| 600 | -1.19979 | 0.0104 | -1.19971 | -0.006 | 0.020 | -0.28 |
| 800 | -1.59990 | 0.0104 | -1.59977 | -0.008 | 0.020 | -0.37 |
| 1000 | -2.00003 | 0.0123 | -1.99991 | -0.006 | 0.024 | -0.24 |

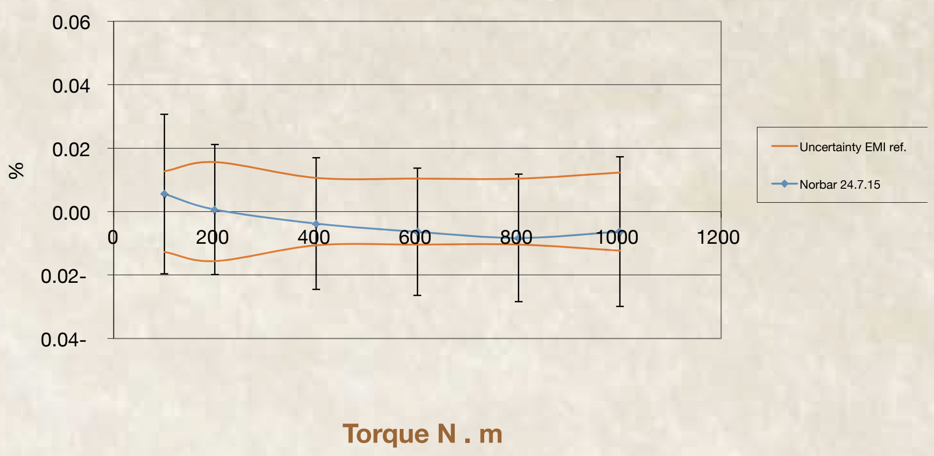
The En ratio is calculated according to the following formula:

$$E_n = \frac{R_1 - R_2}{\sqrt{(U^2_1 + U^2_2)}}$$





**En for GTM transducer type DmTN sn.59737, using supported beam sn.34553, calibrated CW at Norbar UK**

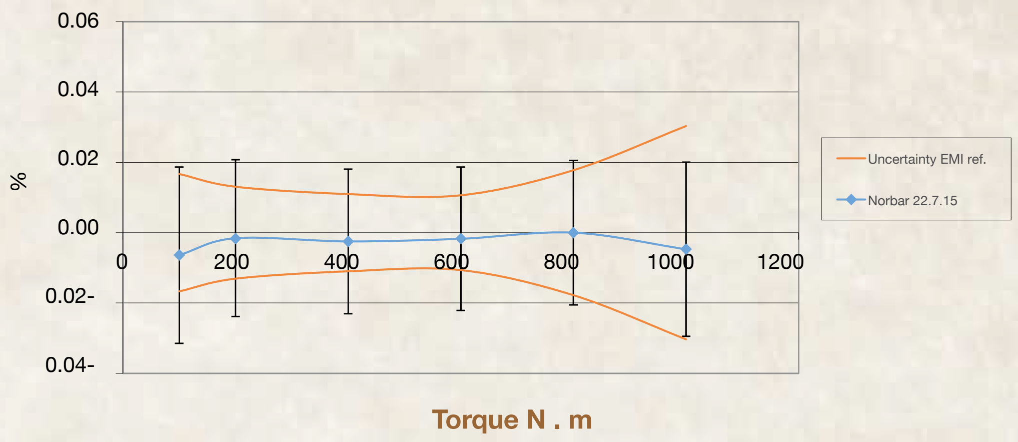



| N·m | EMI Ref. Values | EMI Uncertainty k=2 U2 | Norbar Values | | Norbar uncertainty k=2 U1 | En ratio |
|---|---|---|---|---|---|---|
| | mV/V | % | mV/V | % deviation | % | |
| 100 | 0.19988 | 0.0167 | 0.19986 | -0.006 | 0.025 | -0.212 |
| 200 | 0.39978 | 0.0131 | 0.39978 | -0.002 | 0.022 | -0.060 |
| 400 | 0.79970 | 0.0110 | 0.79968 | -0.002 | 0.021 | -0.106 |
| 600 | 1.19969 | 0.0106 | 1.19967 | -0.002 | 0.020 | -0.075 |
| 800 | 1.59972 | 0.0178 | 1.59972 | 0.000 | 0.021 | 0.000 |
| 1000 | 1.99980 | 0.0303 | 1.99971 | -0.005 | 0.025 | -0.120 |

The En ratio is calculated according to the following formula:

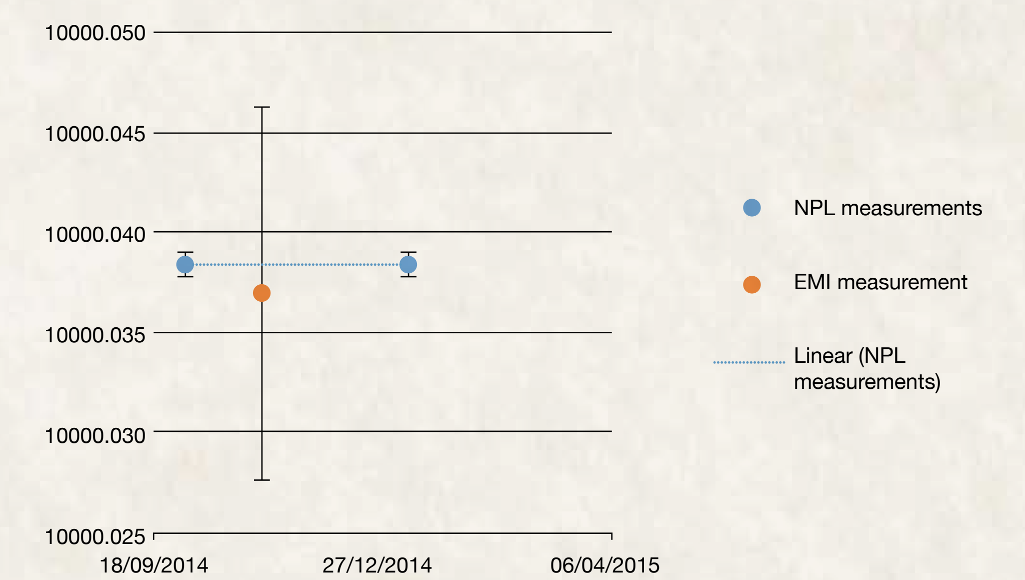
$$E_n = \frac{R_1 - R_2}{\sqrt{(U^2_1 + U^2_2)}}$$

**En for GTM transducer type DmTN sn.59737, using supported beam sn.34553, calibrated CW at Norbar UK**




## ELECTRICAL LABORATORY

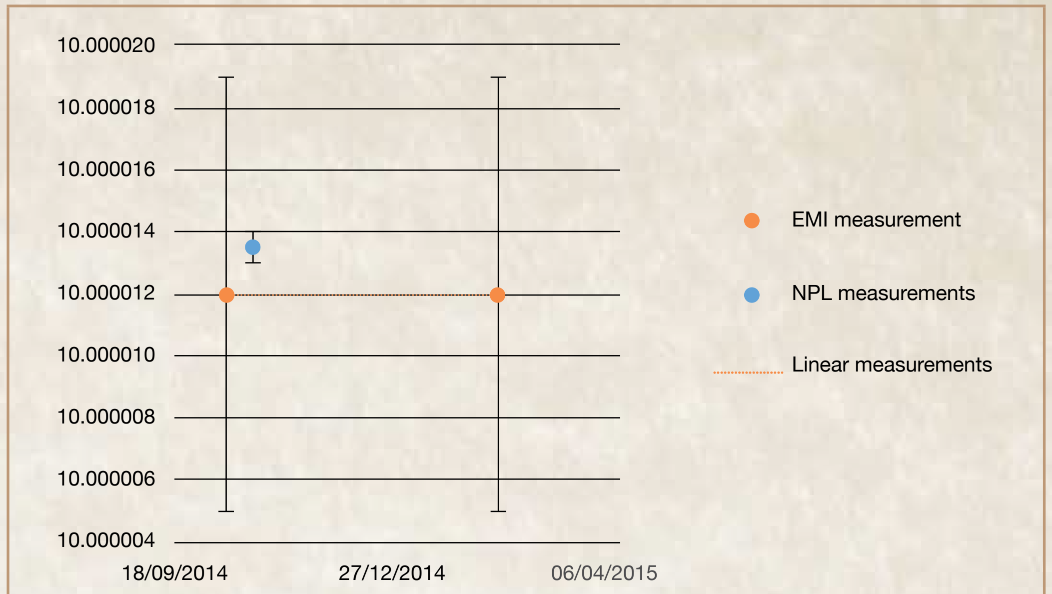
| Figure | Nominal value | NPL | EMI | Difference | En |
|---|---|---|---|---|---|
| Resistance comparison | 10 kΩ | 10000.0386 | 10000.0370 | -0.0016 Ω | -0.172 |




Resistance comparison



| Figure | Nominal value | NPL | EMI | Difference | En |
|---|---|---|---|---|---|
| Voltage comparison | 10 V | 10.000013510 | 10.0000120 | -1.51 μV | -0.215 |




Voltage comparison

CUSTOMERS AND STAKEHOLDERS

## 11. Customers and Stakeholders

| Customers & Stakeholders | |
|---|---|
| Military Air Force | Emirates Authority for Standardization & Metrology |
| Abu Dhabi Farmers' Service Center | Abu Dhabi National Oil Company |
| QCC Legal Metrology | Air Force Military Calibration Lab |
| QCC CTL | EMAL |
| Rohde & Schwarz Emirates | Emirates Nuclear Energy Corporation |
| GE International Operations | Emirates Steel |
| Anaum Test & Measurement | Environment Agency - Abu Dhabi |
| PTECH | Etisalat |
| Himatrix | Health Authority - Abu Dhabi |
| Precision Electro Mechanical EST | Khalifa University |
| Gulf MECHATRONICS | Masdar Institute of Science and Technology |
| TAWAZUN | Regulation & Supervision Bureau |
| Atlanta Instrumentation & Oil Field Services Co.LLC | The Petroleum Institute |

| Customers & Stakeholders | |
|---|---|
| Etihad Airways | UAEU |
| Cleveland Hospital | Haris Al Afaq |
| Arrow Balance | NPCC |
| Emirates Airline | Petroleum Council |
| UAE SPACE AGENCY | SEWA |
| STRATA | YASHAT |
| EIM | Dubai Central Lab |
| KRISS | NPL |
| ADDC | SIRIM |
| AlTaif | NMIJ |
| AMMROC | GULFMET |
| Mohamed Bin Rashid Space Centre | VSL |
| FANR | |

CUSTOMERS AND STAKEHOLDERS

## 12. International Relations and Activities

### MoUs WITH OTHER NMIs

In order to enhance EMI's measurment and calibration capabilities, few MoUs were signed with other well known NMIs

| NMI's | Countries | Date |
|---|---|---|
| **VSL**<br>Dutch Metrology Institute | NETHERLAND | Nov 2013 |
| **EIM**<br>Hellenic Institute of Metrology | GREECE | Dec 2013 |
| **NPL**<br>National Physical Laboratory | UK | April 2014 |
| **METAS**<br>Federal Office of Metrology | SWITZERLAND | May 2014 |
| **SIRIM**<br>Standards & Industrial Research Institute of Malaysia | MALAYSIA | Aug 2014 |
| **KRISS**<br>Korea Research Institute of Standards and Science | KOREA | Sep 2014 |

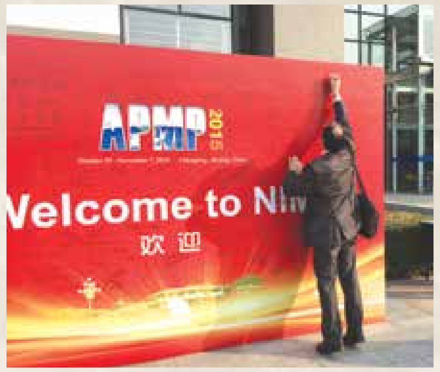


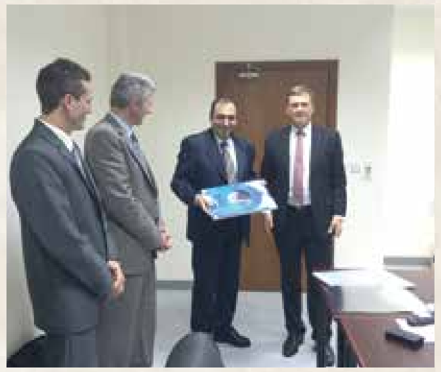


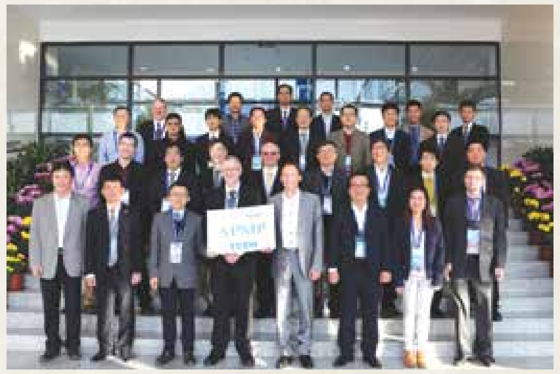


## Participation in ESMA, GULFMET, APMP, and BIPM events

**MASS & RELATED QUANTITIES TECHNICAL COMMITTEE**
**THERMOMETRY TECHNICAL COMMITTEE**
**DIMENSION TECHNICAL COMMITTEE**
**ELECTRICITY, MAGNETISM, TIME AND FREQUENCY TECHNICAL COMMITTEE**
**QUALITY TECHNICAL COMMITTEE**

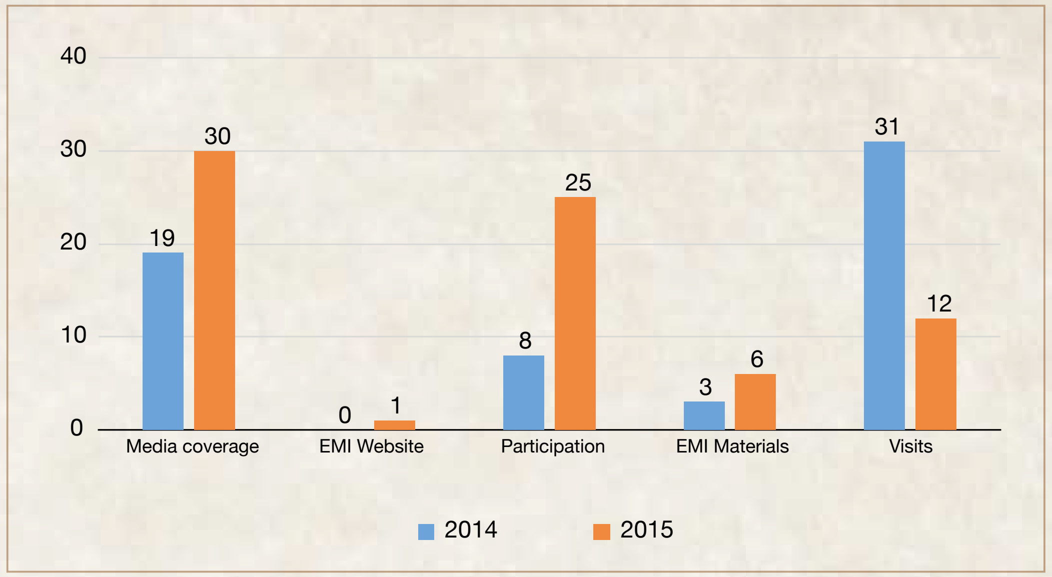




## 13. Media and Communication Activities

EMI Media During 2014 – 2015




### EMI YEARLY GATHERING







### EMI OTHER SOCIAL ACTIVITIES


## 14. Contact Information

### CUSTOMER SERVICE AND PRODUCTION CONTROL DIVISION

**KHALIFA YOUSEF AL AZIZ AL BLOOSHI**
Dir. +971 2 406 6757
Mob. +971 50 928 3000
Email: k.alblooshi@qcc.abudhabi.ae

**SULTAN MOHAMED AL MENHALI**
Dir. +971 2 406 6526
Mob. +971 50 996 6022
Email: s.almenhali@qcc.abudhabi.ae

### MEDIA AND MARKETING

**SULTAN SALEM ALKAABI**
Dir. +971 2 406 6620
Mob. +971 50 623 3494
Email. s.alkaabi@qcc.abudhabi.ae

**WALEED YAHYA ALKALBANI**
Dir. +971 2 406 6533
Mob. +971 50 889 0090
Email. w.alkalbani@qcc.abudhabi.ae

Website: EMI.ABUDHABI.AE