BIPM Capacity Building & Knowledge Transfer Programme

2022 BIPM - TÜBİTAK UME Project Placement

REPORT

Project Name	Calibration of hand torque tools and torque measuring devices.
Description	Calibration and uncertainty calculation of hand torque tools and torque measuring devices according to their specific guidelines/standards and generating reports meeting the requirements of ISO/IEC 17025 standard.
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Mentor at TÜBİTAK UME	
Date	September 5th, 2022 – November 30th, 2022.

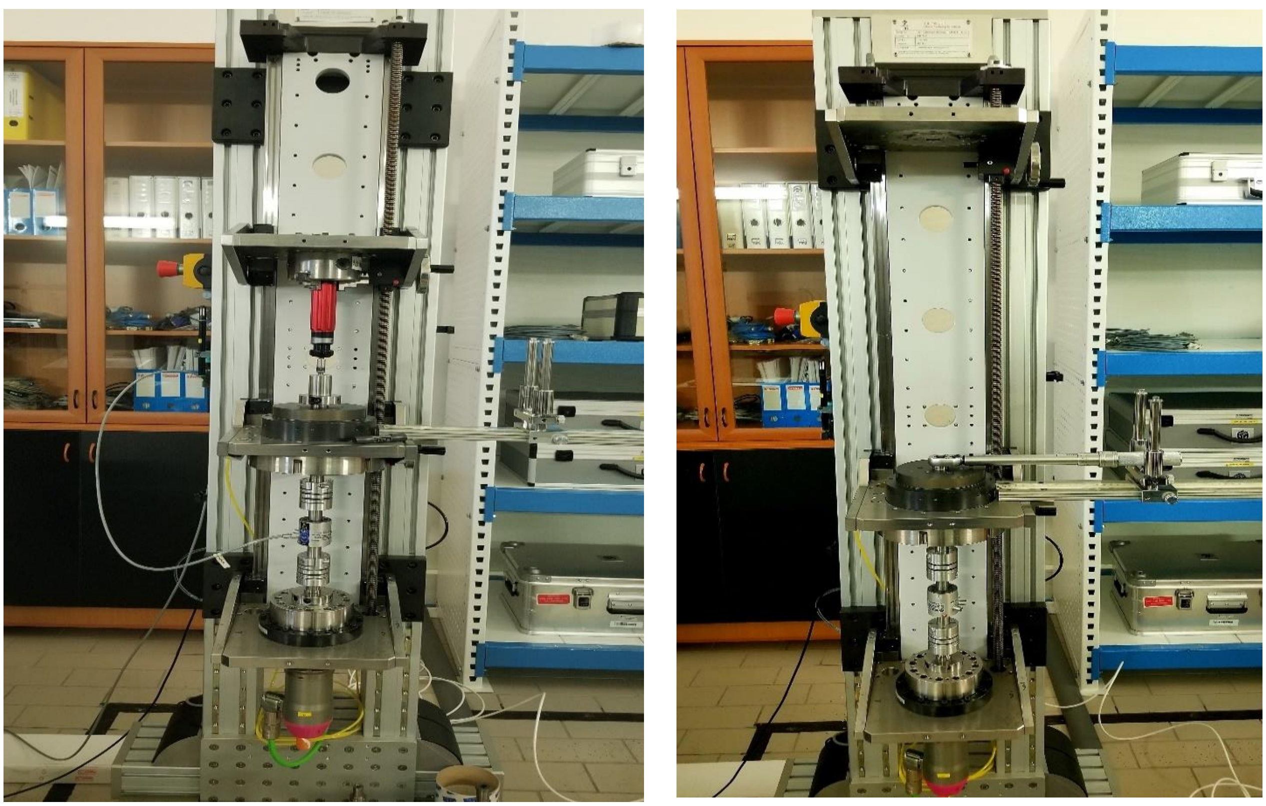
Motivation & Introduction

Guyana, a country that is known for its natural resources and attractions has recently began witnessing rapid development, the main reason being the discovery of its crude oil reserves. With the oil industry growing and paving way for other industries in the country, the demand for metrological services is rising. The Guyana National Bureau of Standards is responsible for standards and quality in Guyana and is charged with the responsibility of administering the Weights and Measure Act of 1981 and Order No.4 of 2001. Our calibration services and ranges must undergo major additions and increases as the National Metrology Institute (NMI) of Guyana and to meet the requirements of our new clients. This initiative is aimed at improving our capabilities in torque metrology, being a service with high demand. It is envisaged that at the end of this initiative, I would be able to gain knowledge on the calibration of torque wrenches, torque screwdrivers, torque multipliers and any other torque measuring device. I should also develop an understanding of uncertainty budgets for the calibration of the said torque devices. As such, increasing skills necessary for conducting calibration activities in a laboratory environment. By gaining these experiences at such a recognized institution, I should develop some understanding on preparing a draft Technical Standard Operating Procedure for the calibration of torque devices. This should also enable me to prepare calibration reports with the requirements of the ISO/IEC 17025 standard. The experience gained throughout this initiative will be very important, since it will equip me with the necessary knowledge needed to assist the Guyana National Bureau of Standards with the effective layout, installation and commissioning of equipment which has been previously purchased. I will also be able to make decisions on placement, installation and commissioning of the equipment purchased to optimize use and functioning and to ensure adherence to health and safety standards. Upon successful completion of my training, I will use my knowledge and experience gained to increase the capacity of the Guyana National Bureau of Standards in providing calibrations for said torque devices. Torque calibration is very important for the oil industries and aeronautical engineering services in Guyana and this training opportunity will enable us to expand in torque metrology. This should benefit the country’s industries and positively impact the development of the National Metrology Institute (NMI).

Research

When I Arrived at TÜBITAK UME, my knowledge and experience in torque metrology and calibration was limited to only hand torque tools. Acknowledging that this is not enough to reach the standard of a National Metrology Institute (NMI) and the requirements of clients in my country, my main aim was to expand my knowledge as much as I can and to use this opportunity in a well-developed laboratory to the best of my advantage. I took a very basic and effective approach towards my research; it was simply to begin from the basics with whatever experience I had prior to coming to TÜBITAK UME and build on that. My method consisted of firstly, reading and understanding of the standards and guidelines that governed the area in which I was researching. Then I moved on to the practical application and calibration of the equipment in that area, gaining firsthand experience. After which, I proceeded to the creation of the uncertainty budgets that is used to calculate the measurement uncertainty of the calibration. With all those steps completed, the only step left to cover was the reporting of the calibration results by preparing a calibration certificate or report. Each step was completed while reaching the requirements of the ISO/IEC 17025 standard for the competence of testing and calibration laboratories. The reason for choosing this specific method and approach to my research is mainly to gain complete knowledge of the process of calibration of torque devices, as being done in UME and doing so in a step-by-step action which is very transparent and allows me to witness every detail in the process.

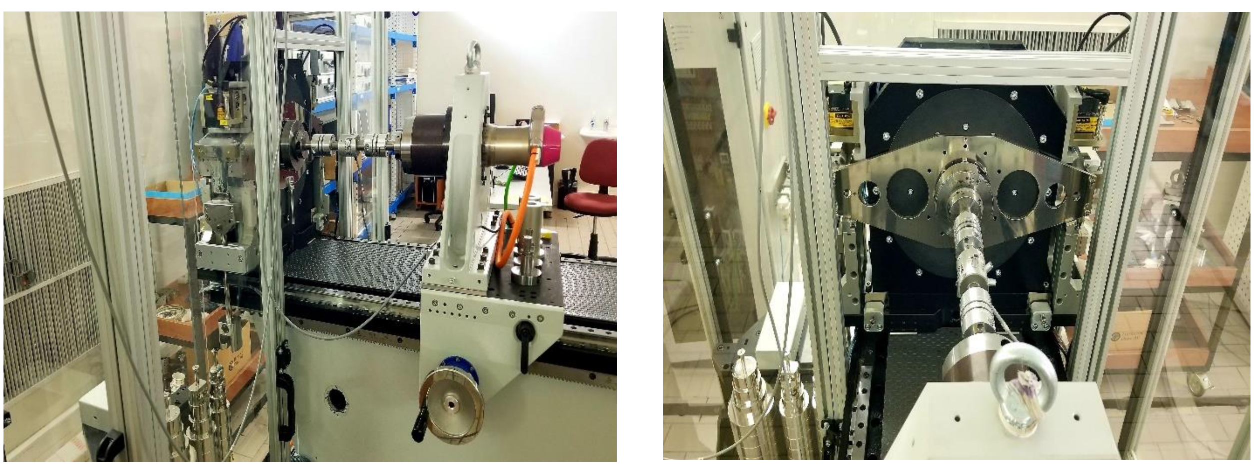
My research began in the sub-area of hand torque tools calibration. I firstly got familiar with the BS EN ISO 6789-1: 2017 which stated the requirements and methods for design conformance testing and quality conformance testing: minimum requirements for declaration of conformance. This is a standard used widely and by UME from the BSI Standards Publication. The next standard used was the BS EN ISO 6789-2 2017 which listed the requirements for calibration and determination of measurement uncertainty for hand torque tools, also from the BSI Standards Publication. Following the guidelines of these standards, we then proceeded to perform the calibrations of each type of hand torque tool listed in the ISO 6789-1 2017. These calibrations were done on the 100 N m torque calibration machine (TCM-RTT-100-Nm) and the 3000 N m Hand torque tool calibration device (T-RTT-03) that was designed in UME and produced in Türkiye. After completing the practical part of the calibration, I moved on to the uncertainty budget and calculation of uncertainties for the calibrations. This was done by following the guidelines of BS EN ISO 6789-2 2017. With the help of my mentors, I successfully created an uncertainty budget for each type of hand torque tool and the next step was to generate the results and reports, while complying with annex C of ISO/IEC 17025 standard.



Calibration set up for type 2, class D (left) and type 2, class A (right) hand torque tools using the 100 N m Torque Calibration Machine (TCM-RTT-100-Nm).

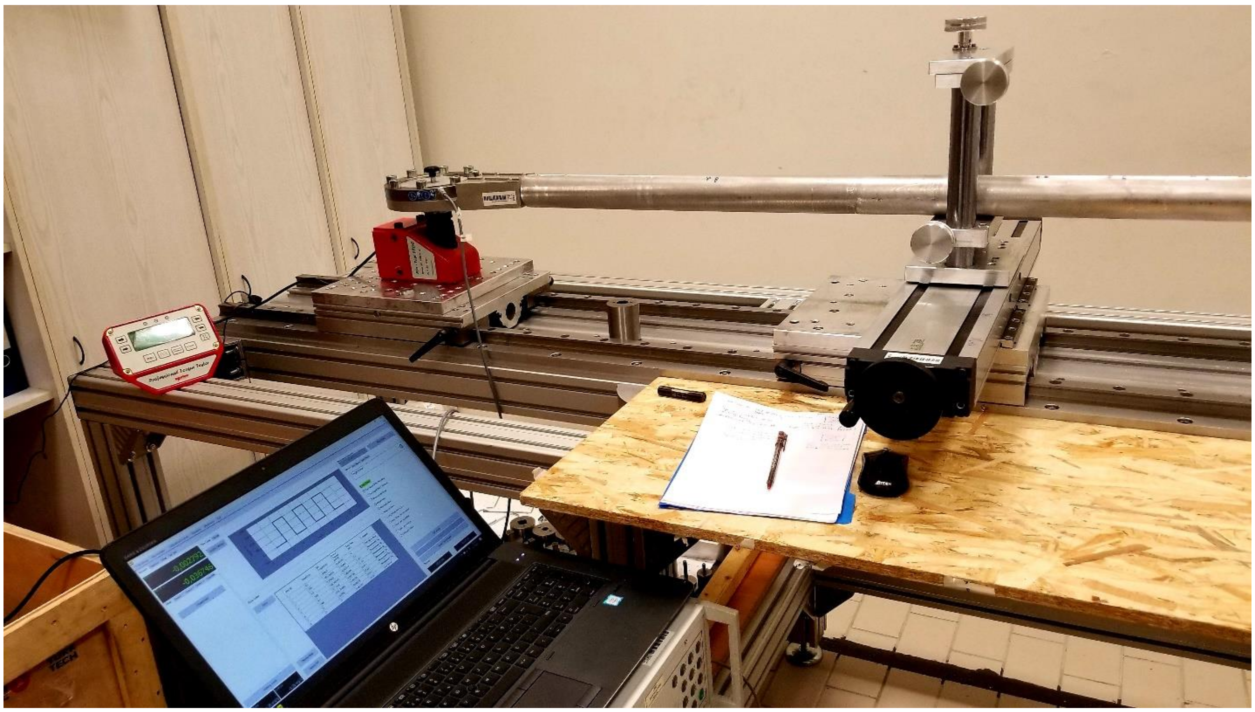
Calibration of a type 2, class A torque wrench (3000 N m) with arm length extension using the 3000 N m Hand torque tool calibration device (T-RTT-03).

After I completed my research and applications on the calibration of hand torque tools, I then moved on to the next sub-area and a more technical one being the calibration of static torque measuring devices (static torque transducers). The approach remained the same for this area. With the help of my mentor, I first gathered the guidelines and standards used when carrying out calibrations of these devices and began reading and understanding them thoroughly. These guidelines and standards were, EURAMET cg-14 Guidelines on the calibration of static torque measuring devices (version 2.0 03/2011) and DIN 51309:2005-12 Materials testing machines - calibration of static torque measuring devices, English translation. We then moved on to the practical application in the form of calibration of a static torque transducer using the 50 N m Lever mass, torque standard machine (TSM-DW-50-Nm) that was also designed by UME and produced in Türkiye. The data was collected for the calibration and the next step was to begin building the uncertainty calculation budget and to generate the results of the calibration. With the help of my mentor, I successfully built an uncertainty budget for the calculation of measurement uncertainty of the calibration and classification of the static torque measuring device, following the guidelines of the standards. This research will prove to be very useful for me in expanding our services at the Guyana National Bureau of Standards and it will be an area I will work towards developing now that I have the knowledge and experience.



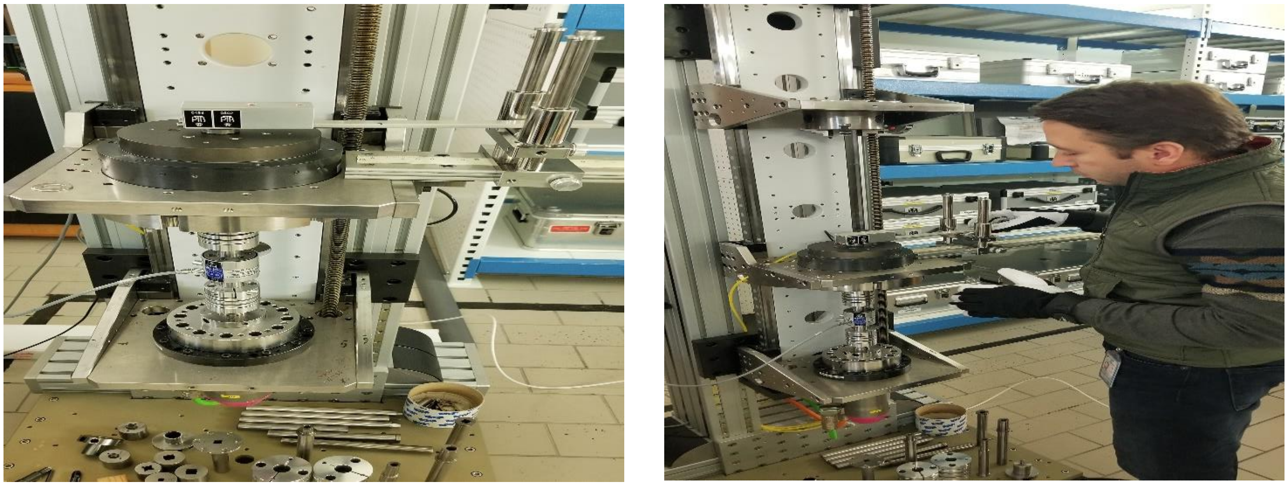
Calibration (set up) of a 50 N m static torque transducer, using the 50 N m Lever mass, torque standard machine (TSM-DW-50-Nm).

My research continued with the next sub-area of the torque laboratory, calibration of Hand torque tool testers. The Guidelines/standards used for this area is DKD-R 10-8, Static calibration of calibration devices for torque wrenches and BS 7882:2017, Method for calibration and classification of torque measuring devices. After studying the standard, and understanding the procedure for carrying out the calibration, we proceeded to the practical application (calibration) of a Professional torque tester, Norbar pro test 1500 (N m). A reference torque wrench was used to carry out this calibration with a capacity of 3000 N m. This along with the device under calibration was installed on the 3000 N m Hand torque tool calibration device (T-RTT-03) and the calibration was carried out following the guidelines of the DKD-R 10-8 and BS 7882:2017. After calibration and recording of data, with guidance of my mentor, we built an uncertainty budget for the calculation of measurement uncertainty for the calibration and classification of the hand torque tool tester. This was also an entirely new area to me, and a lot of knowledge was gained from this experience.



Calibration (set up) of a 1500 N m Norbar Professional Torque Tester, using a 3000 N m reference torque wrench, installed onto the 3000 N m Hand torque tool calibration device (T-RTT-03).

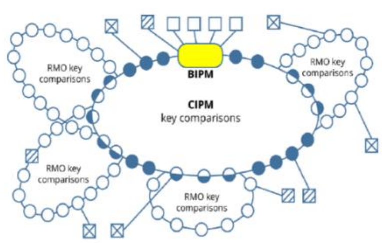
The last sub-area that my research covered was the calibration of reference torque wrenches. Another unfamiliar area to me. I began once again by obtaining the standard or guideline that is applied to this calibration area. This was the Directive wrenches DKD-R 3-7, Static calibration of indicating torque. The guideline was then used to apply a practical calibration of a reference torque wrench, using a calibrated static transducer, installed onto the 100 N m torque calibration machine (TCM-RTT-100-Nm). Two calibrations were carried out on this device on different days since the results of the first calibration did not indicate as accurate results as we expected. The second calibration was carried out with more attention to the installation and application of each calibration step. The results proved to be more accurately aligned with the expected results, based on the previous calibration certificate. While going through this research I surely gained firsthand experience on each step of the calibration process and the problems that can be encountered when carrying out calibration on such a sensitive and accurate equipment. We then proceeded to build the uncertainty budget for the calculation of measurement uncertainty and classification of the reference torque wrench. This was done following the guidance of my mentor and using the DKD-R 3-7 standard.



Calibration (set up) of a reference torque wrench using a static transducer installed onto the 100 Nm torque calibration machine (TCM-RTT-100-Nm).

An area I was keen on researching was the calibration of torque multiplying devices, torque multipliers. However, it was acknowledged that this was not possible since there is no published standard or guideline that outlines the procedure of performing calibration on such a device. With the help of my mentor, I was made aware of a Proposal for torque multiplier calibration standard by K.M. Khaled and M. Abdulhakim from National Institute of Standards (NIS), Egypt. This paper outlined a proposal for the calibration of torque multipliers and ca lculation of measurement uncertainty of the calibration. Since it was determined that no standards were available to outline the procedure of this type of calibration, we concluded that only a test can be carried out to determine the measurement error of the device and that was the only parameter to be reported if a client is requesting the service. The procedure would be determined entirely by the laboratory providing the service and the client by mutual agreement before carrying out such a service. It should also meet the requirements of the quality management system of the laboratory and should be monitored to maintain same.

During my training at UME, I got the opportunity to be in a webinar that was based mainly on the CIPM MRA and its importance in metrology. I learnt about the background of the CIPM MRA, why it was launched and its functions and objectives. This covered how a National Metrology Institute (NMI) can participate in comparison in the CIPM MRA and have its calibration measurement capabilities (CMCs) published in the BIPM key comparison database (KCDB) and the peer reviews it should go through before publishing, intra-regional review and inter-regional (JCRB) review. The NMI shall also establish and maintain a quality management system (QMS) that meets the requirements of the CIPM MRA and have it reviewed, approved, and monitored by their regional metrology organizations (RMOs). The importance of metrological traceability was also highlighted and how it can be maintained.



There are 3 basic categories
- CIPM key
- RMO key
- Supplementary

Illustration of relations between key comparisons.

This placement brought a lot of clarity and new information to me and one of the main contributors to this was the level of technology and the capacity of the people working at TUBITAK UME. Most of the primary and reference standards were designed by engineers in UME and produced in Türkiye, hence, I had no experience or idea about them before. The metrological concept remains the same and I think development will demand each NMI to improve and become more technologized. This experience will enable me to make a difference in my NMI by improving the area of Torque metrology. I was also given the opportunity to visit a few other laboratories in UME and get an insight into the calibration performed in those areas. This will also prove to be helpful for my institution since we are now developing and embracing the responsibilities of an NMI and our capacities remain to be expanded.

Conclusions and Future Work

At this point, it is safe to say that I achieved all my objectives planned before arriving at TUBITAK UME. I completed calibration of hand torque tools, static torque transducers, hand torque tool calibrators and reference torque wrenches calibration. I built uncertainty budgets for each area of calibration, and I reviewed my procedure and reporting all to the requirements of ISO/IEC 17025 standard. I also researched the calibration of torque multipliers and arrived at how to handle requests of the service from clients at my NMI in the future. I took the opportunity to visit some other laboratories in UME and gained valuable knowledge that would help me in the development of those areas in my NMI. With the knowledge and tools gained from this initiative, I look forward to starting the improvement and expansion of torque metrology in my NMI and sooner than later, start participating in comparisons in the CIPM MRA. I think my training plan and schedule was executed successfully and in the most comfortable way for me, all thanks to the great people at TUBITAK UME.

Acknowledgements

My visit to TUBITAK UME has been very successful and it is an experience I will never forget. None of It would be possible if it wasn't for the numerous persons that put in their effort to make this initiative possible, from the beginning to the end of this placement. It brings me great pleasure to acknowledge and appreciate these individuals that played their part in my training experience. I would like to thank the BIPM and TUBITAK UME for providing this opportunity for metrologists. My mentors in the torque laboratory in UME, Mr. Çetin DOĞAN and Mr. Semih TUNACI did an amazing job in nurturing me with knowledge and guiding me through every step of my research and training, they provided every tool and guideline needed in a very efficient way and they were always there to answer any question I had. They even went out of their way to make me feel welcomed and comfortable by treating me to leisure activities and introducing me to the Turkish food and culture. I would like to extend sincere appreciation to them for the wonderful job they did in making me feel comfortable and sharing their knowledge with me. While in UME I also got to visit some other laboratories and witness calibrations and gain insights in their respective areas of metrology. The staff of those laboratories were most welcoming and happy to accommodate me and for that I must acknowledge them. Mr. Erçan PELİT and Mr. Çihan KUZU From the hardness laboratory, Dr. Gökçe Sevim SARIYERLİ from the volume, density and viscosity laboratory, Dr. Beste KOROTLU and Mr. Gökhan Öner from the mass laboratory, Dr. Murat KALEMCİ from the temperature laboratory, Ms. Sevim CEVAHIR SENLIKCI From fluid laboratory, Mr. Atilla VAROL, and Mr. Abdullah HAMARAT from the pressure laboratory. I acknowledge the efforts of Mr. Andy Henson, Mr. Chingis Kuanbayev and Mr. Enver Sadıkoğlu for the presentations in the webinar and educating us on the CIPM MRA and its functions. I extend gratitude to Ms. Müge ATAM for taking charge of our accommodation and transportation schedules throughout my stay and for providing relevant information as needed. I Thank my institution, the Guyana National Bureau of Standards for giving me this opportunity and I look forward to making improvements in my country with my experience.