IMEKO 22nd TC3, 15th TC5 and 3rd TC 22 International Conferences
3 to 5 February, 2014, Cape Town, Republic of South Africa

# FORCE TRACEABILITY WITHIN THE MEGANEWTON RANGE

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**Abstract:** This paper gives an introduction and an overview about the structure and the research work carried out in the new EMRP Joint Research Project SIB63 "Force" with the title "Force traceability within the meganewton range".

**Keywords:** Force, Build-up Systems, Mega Newton

## 1. INTRODUCTION

In a broad range of industrial branches such as mechanical engineering, the aerospace industry, wind industry, building industry, safety engineering and testing, forces with nominal values in excess of 15 MN are measured. The application of force measuring devices can be totally different from their calibration. The main reasons for this are different mounting conditions, different force introduction components, different loading profiles and different time influences. Traceable calibration of suitable transfer standards should improve the measurement of forces in industrial applications. In order to reduce the uncertainty of measurement in practical applications, parasitic components and effects that are related to real loading procedures (which might be very different from the static calibration procedures) have to be taken into account. Furthermore, the force range needs to be extended to larger nominal values because there is an increasing demand for traceable calibrations in the MN range for forces up to 30 MN in European industry, in future maybe even up to 50 MN.

Therefore, newly developed highest nominal value force transfer standards have to be investigated in order to improve the measurement of forces and the dissemination of the quantity of force. In addition parasitic components and different loading effects will be analyzed to consider these effects when the device is used in industrial applications.

In the highest force range, build-up systems are used, however, open questions exist regarding the uncertainty evaluation of such systems. It is therefore necessary to provide end users with procedures on using this kind of force measurement device in this highest force range and to develop corresponding methods of uncertainty calculation.

To investigate these effects, the EMRP Joint Research Project SIB63 "Force" with the title "Force traceability within the meganewton range" has started in July 2013 [1]. The aim of this paper is to give an introduction to this project.

## 2. SCIENTIFIC AND TECHNICAL OBJECTIVES

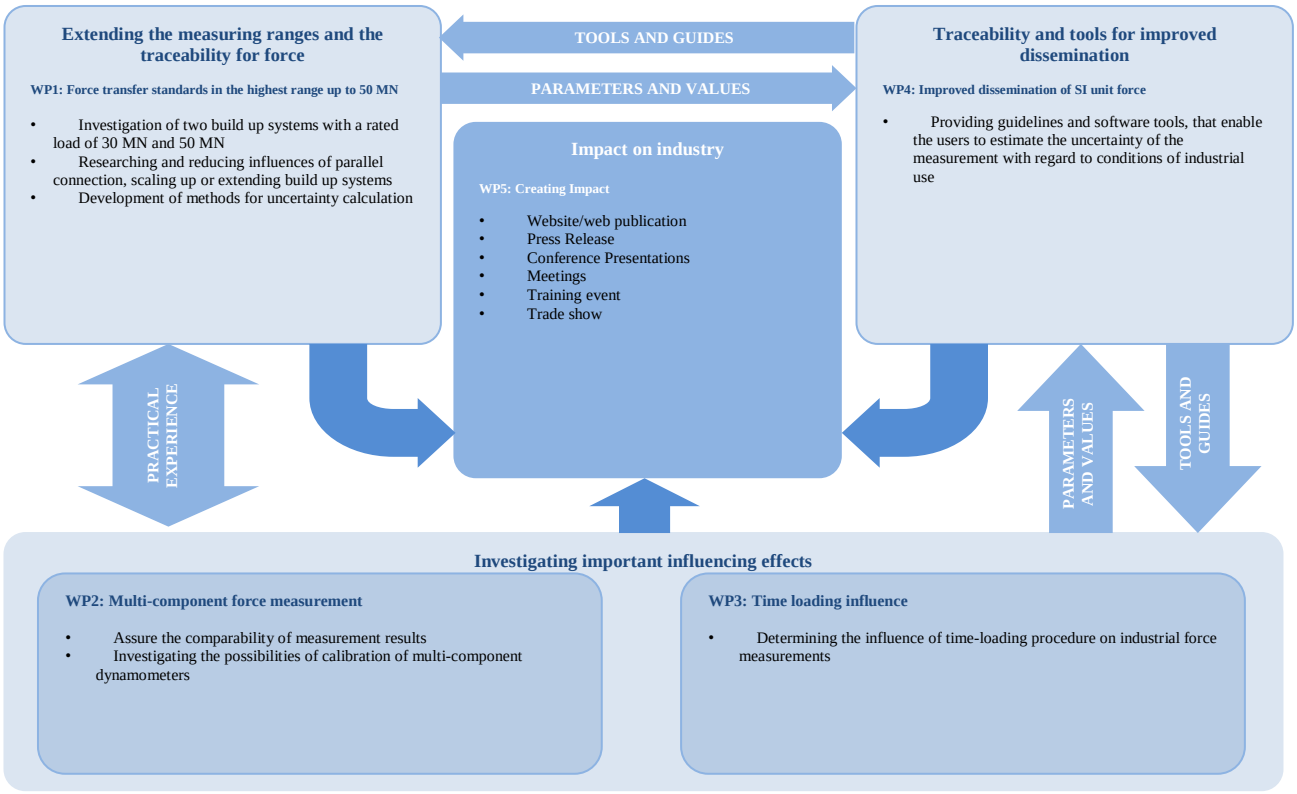
This JRP addresses the following scientific and technical objectives:

1. To extend the range of primary force standards to cover the range from 1 MN to 30 MN or higher up to 50 MN, with uncertainties of the order of 0.002 % up to 2 MN, 0.01 % up to 15 MN and 0.05 % up to 30 MN.
2. To develop improved transfer standards for forces up to 30 MN, in order to enable both more reliable dissemination of the unit of force and improvements in the measurement of force in industry. The effect on the overall uncertainty in use due to parasitic components and loading procedures that are different to the static calibration procedure, for example in the case of continuous or non-axial loading will be evaluated.
3. To develop uncertainty models to determine the uncertainty of the whole build-up force measurement system, rather than addressing the calibration of single transducers.
4. To develop methods to extrapolate calibration results for values higher than 15 MN force, including evaluation of the associated uncertainties.
5. To develop new procedures and EURAMET technical guides for users in calibration and testing laboratories on the use of high force measurement devices, the methods of uncertainty calculation and on the improvements in the dissemination of force from primary standards to calibration services and testing laboratories.

## 3. DETAILED PROJECT PLAN

The objectives in this JRP are considered in 6 work packages (WPs). Their interaction is shown in Fig. 1.

WP1 "Force transfer standards in the highest range up to 50 MN" considers the extension of the traceability in force measurement by new transfer standards with reduced uncertainties. BUSs with nominal forces up to 30 MN and 50 MN will be investigated within this WP. Researching and reducing influences of parallel connection, scaling up or extending BUSs is another focus of this WP. Finally, new methods for uncertainty calculation will be developed.




WP2 “Multi-component force measurement” considers measurement capabilities for force and of monitoring spurious components are not well characterised and result in undefined measurement errors. One important goal is to assure the comparability of the measurement results. An investigation of the possibilities for the calibration of multi-component dynamometers completes this WP.

WP3 “Time loading influence” considers that during the calibration the transducer is loaded using precise load steps, whereas in industrial use this type of loading is generally not possible. The calibration procedure according to ISO 376 specifies a preload, generally not used in industry, due to the operational conditions of the transducer. The influence of the time-loading procedure on industrial force measurements will be determined.

WP4 “Improved dissemination of SI unit force” considers the traceability from the NMIs to the laboratories in industry. While calibration takes place under laboratory conditions, difficulties can arise in industrial environments since conditions may vary (temperature, humidity, transducer arrangement etc.). Hence, the aim of this WP is to reduce the uncertainty and increase the reliability of measurement results. Within this WP software tools will be provided that enable users to estimate the uncertainty of force measurement based on more realistic conditions of usage in industrial environments.

WP5 “Creating impact” is related to the output of this JRP is to be disseminated widely to NMIs and key industrial players. In the early stages of this JRP, direct contact with various stakeholders will be extended and strengthened. This will enable the integration of JRP-Collaborators’ requirements at an early stage of the JRP. Moreover, a specific dissemination strategy will be implemented to foster good practice in technology transfer.

WP6 “Management and coordination” is finally the management of this JRP.

## 4. ACKNOWLEDGEMENT

The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union.

## 5. REFERENCES

**References:**

[1] JRP website address: http://www.ptb.de/emrp/forcemetrology.html