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TRACEABILITY IN FORCE MEASUEMENTS FROM THE CENTER TO THE REGIONAL LABORATORIES

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Abstract - A national traceability in force measurement to the Regional Reference Standards Laboratory (Department of Legal Metrology) without much degradation in the uncertainty while transferring the unit from the National standards to the user is achieved by developing and commissioning a dead weight force machine of 50 kN capacity at Regional Reference Standards Laboratory (RRSL), Bangalore and 50 kN comparator type force machines at other (RRSLs located at different parts of India. The established standard machines are directly compared for their performance through an artifact calibrated against the NPL primary standard machine having a BMC of ± 0.003 % (k=2). The load cell calibration data obtained from the different machines show that the realized force is found to be within ± 0.05% and hence the performance of the established force standard machines is highly satisfactory.

Key words: force metrology, traceability

1. INTRODUCTION

In the present scenario, it is essential for metrological laboratory and industries to work hand in hand to keep abreast with the dynamic changes occurring in the measurement science for the economic growth of the country. Traceability in measurement is a key factor for the industries to get a better recognition and also to improve the competitiveness of the products developed across the world. The industrially manufactured components and products and further improvement in quality therein largely depend on the calibration and measurement capability (CMC) of the NMI of the country. National Physical Laboratory, India (NPLI) has the obligation to establish, maintain and upgrade the national standards [1,2] and to provide traceability in measurements for all the physical and electrical parameters to the users. Also NPLI's status as a signatory of the CIPM-MRA (Mutual Recognition Arrangement), gives confidence to its clients about the CMC values and the effectiveness of the quality management system.

Force is a widely used mechanical parameter among industries such as automobile, chemical, civil aviation, defense, etc., therefore it should necessarily be traceable with an unbroken chain of calibrations to the national standards. Though there are accredited calibration laboratories performing the calibration of several measuring equipment in various fields to provide traceability to the shop floor level, it is desirable to have a well structured system to achieve this task in a more economic and effective manner for safeguarding the consumer interest. In view of this, the force and hardness standard group of NPL has embarked upon a comprehensive plan to establish the reference standard of force at one of the Regional Reference Standard Laboratories (RRSL, Department of Legal Metrology, Ministry of Consumer Affairs, Food and Public distribution) to realize force up to 50kN, which can be used as a reference standard to provide national traceability to other RRSLs located in different parts of the country. NPLI has designed, developed and commissioned a 50kN dead weight force standard machine at RRSL, Bangalore and a few 50kN comparator type force calibrating machines at other RRSLs. This would enable NPLI to provide and maintain the traceability chain in force measurement to RRSL, Bangalore more efficiently without much degradation in transferring the unit which in turn will provide the traceability to the other RRSLs. The advantages of the established system is manifold, including (i) the reaffirmation of the associated uncertainty in the force measurement among RRSLs by carrying out inter-laboratory comparisons, (ii) providing traceability in force measurement to the user industries without much degradation of the realized force, and (iii) artifact can be sent to RRSL Bangalore for recalibration of the entire system which would expedite the process in terms of time besides economizing the cost. The effective implementation of this system would provide assurance of Government of India notification for safeguarding the consumer interest.

2. ESTABLISHMENT OF FORCE STANDARD MACHINES AT REGIONAL REFERENCE STANDARD LABORATORIES

A dead weight force machine of 50 kN capacity is designed and developed using all dead weights and other loading part made of stainless steel. The main frame of the machine consists of a number of the horizontal plates separated by spacers at its all four corners to support the

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dead weights. The dead weights are loaded to the loading hanger to generate the required force using a pneumatic system to minimize the vibration and oscillation to obtain force stabilization in a short time. Force transducer under calibration is placed on the upper part of a horizontal adjustable platen and the required force steps are generated by pneumatically actuating the solenoid valves of the selected dead weights. The calibrated loading hanger always remains as the first minimum force step to be applied. The dead weight force machine shown Fig. 1 is in operation at RRSL, Bangalore. Its performance was verified using 20 kN and 50 kN (HBM, Germany) force transducers in compression mode, which were directly calibrated on the NPLI dead weight force machine having the BMC of ± 0.003%.

Fig. 1. 50 kN dead weight force machine.

NPLI has also designed and developed a few comparator type 50 kN force calibrating machine using a set of reference force transducers up to 50 kN capacity (Fig. 2).

Fig.2: Comparator 50 kN force machine.

These machines have been installed and commissioned at regional reference laboratories located at different parts of India. These laboratories, which use their established systems for calibration, testing and evaluation of force transducers and proving rings for the industries, would get their traceability from the nodal RRSL located in Bangalore, India, which in turn will be directly traceable to NPLI. The traceability chain in force measurement is thus achieved efficiently with a lowest possible uncertainty all over India in a limited force range as depicted in the Fig.3.

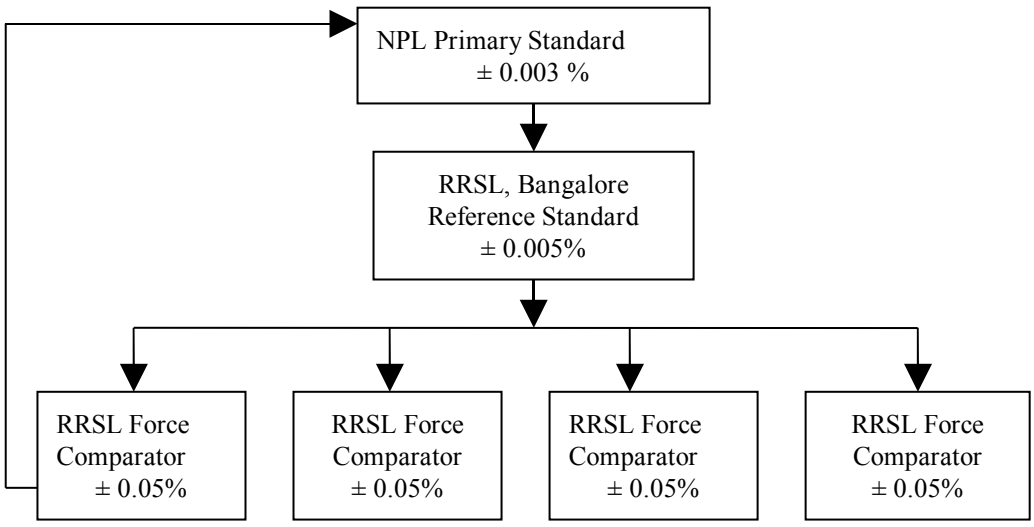

Fig 3: Traceability chain from NPL to different RRSLs.

The experimental values observed by calibrating a 50 kN force transducer as per the standard procedure on different machines show a close agreement with a E_n value below 1, which adds further confidence in force measurements using these machines across the country. The experimentally observed uncertainty in force measurement using the established system at the nodal lab and one of the RRSLs is given in Fig. 4 and Fig.5. A similar behaviour is observed in calibration data obtained with the 20 kN force transducer calibrated independently on the dead weight and the comparator type force machines, hence is not reported here.

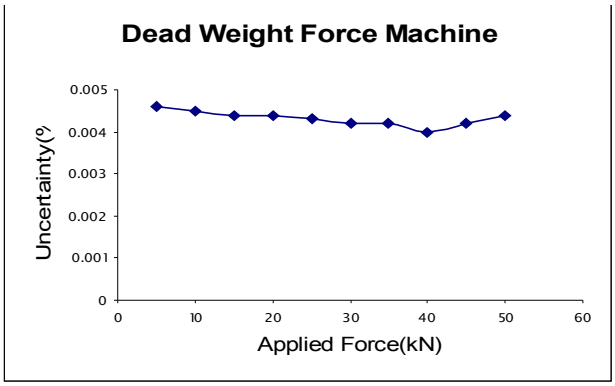

Fig.4: Uncertainty observed in dead weight force machine.

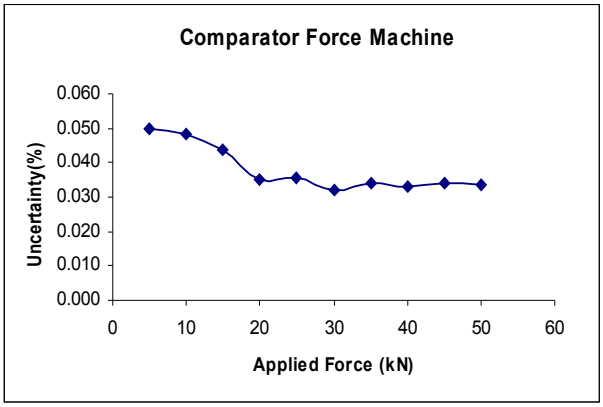

Fig. 5: Uncertainty observed in the comparator force machine.

3. CONCLUSION

A reliable and sustainable dissemination of national traceability in the field of force has been established to transfer the force unit from NPLI to the shop floor level with a minimum loss of accuracy.

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