National Metrology Institute of South Africa
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C.S. Veldman

Technical protocol of the bi-lateral comparison AFRIMETS.AUV.V-S2 (Low frequency sensitivity-*vibration*)

1 Participants

The following two laboratories have been registered as participants in the agreed bi-lateral comparison, AFRIMETS.AUV.V-S2 (for contacts see below):

Contact details of participating laboratory representatives:

For **NMISA** / South Africa (Pilot Laboratory)

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2 Task and Aim of the Comparison

The aim of this bi-lateral comparison, AFRIMETS.AUV.V-S2, is to measure the sensitivity of an accelerometer with primary means in accordance with ISO 16063-11 “Methods for the calibration of vibration and shock transducers -- Part 11: Primary vibration calibration by laser interferometry”. The reported sensitivities and associated uncertainties are then to be used for the calculation of the Degrees of Equivalence (DoE) between the participating NMIs.

The specific task of this comparison is the measurement of the modulus of the complex voltage sensitivity of an accelerometer complete with power supply unit (PSU) at different frequencies and acceleration amplitudes as specified in clause 3. The voltage sensitivity shall be calculated as the ratio of the amplitude of the output voltage of the accelerometer complete with PSU to the amplitude of the acceleration at its reference surface. For this comparison, the top of the accelerometer (BB) as well as the base of the accelerometer (SE) will be used as reference surfaces.

The modulus of the voltage sensitivity shall be given in milli-volts per metre per second squared (mV/(m/s²)), for the different measurement conditions specified below.

3 Conditions of measurement

3.1 Frequencies in Hz:
0,4 Hz, 0,5 Hz, 0,63 Hz, 0,8 Hz, 1,0 Hz, 1,25 Hz, 1,6 Hz, 2,0 Hz, 2,5 Hz, 3,15 Hz, 4,0 Hz, 5,0 Hz, 6,3 Hz, 8,0 Hz, 10 Hz, 12,5 Hz, 16 Hz, 20 Hz, 25 Hz, 31,5 Hz, 40 Hz
(16 Hz as reference frequency)

3.2 Acceleration amplitudes:
A range of 0,1 m/s² to 50 m/s² should be complied with (considering the displacement and acceleration limitations of the LF vibration exciter).

3.3 Ambient temperature and accelerometer temperature during the calibration
(23℃ ± 3) ℃ (actual values to be stated within tolerance s of ± 0,5 ℃).

3.4 Relative humidity: max. 75%.

3.5 Mounting torque of the accelerometer: (2 ± 0,1) N·m.

4 Transfer standard

As transfer standard, a double-ended piezoelectric accelerometer will to be used:

- Accelerometer – PCB 301M26, Serial number 1969
- PSU - PCB 482A21, Serial number 1778

Note: *The accelerometer with PSU will be provided by the NMISA (property of NMISA).*

5 Measurement instructions

The participating laboratories have to observe the following instructions:

- The accelerometer, complete with PSU shall be calibrated as a unit.
- The motion of the BB accelerometer should be measured with the laser directly on the top surface of the transducer without any additional reflector or dummy mass.
- The motion of the SE accelerometer should be measured on the moving part of the vibration exciter, close to the accelerometer's mounting surface, since the mounting (reference) surface is usually not directly accessible.

- At low frequencies it is acceptable to use a retro-reflector in order to facilitate optical alignment of the interferometer during measurement of the displacement.
- The mounting surface of the accelerometer and the moving part of the exciter must be slightly lubricated before mounting.
- The cable between accelerometer and amplifier should be taken from the set of DUT delivered to the laboratory.
- In order to reduce the influence of non-rectilinear motion, the measurements should distributed over the respective measurement surface.

- It is advised that the measurement results should be compiled from complete measurement series carried out at different days under nominally the same conditions, except that the accelerometer is remounted and the cable reattached. The standard deviation of the subsequent measurements should be included in the report.

6 Communication of the results to the pilot laboratory

Each participating laboratory will submit one printed and signed calibration report for each accelerometer configuration to the pilot laboratory including the following:

- a description of the calibration systems used for the comparison and the mounting techniques for the accelerometer
- a description of the calibration methods used
- documented record of the ambient conditions during measurements
- the calibration results, including the relative expanded measurement uncertainty, and the applied coverage factor for each value
- a detailed uncertainty budget for the system covering all components of measurement uncertainty (calculated according to GUM, [4, 5]). Including among others information on the type of uncertainty (A or B), assumed distribution function and repeatability component.

In addition each participating laboratory will receive two electronic spreadsheets prepared by the pilot laboratory, where the calibration results have to be filled in following the structure given in the files. The use of the electronic spreadsheets for reporting is **mandatory**, the consistency between the results in electronic form and the printed and signed calibration report is the responsibility of the participating laboratory. The data submitted in the electronic spreadsheet shall be deemed the official results submitted for the comparison.

The results have to be submitted to the pilot laboratory within six weeks after the measurements.

7 Time schedule

- ***Calibration and transportation time period:***

  A total time period of 2 months is allocated for each laboratory covering both calibration and transportation.

  - ***Total circulation period*****:** Max. 6 months
  - ***Final report*****:** July 2011

8 Transportation

The transfer standards will be transported in a closed box by a representative of the NMISA to the representative of INMETRO. The transfer standards will be returned to a representative of the NMISA by a representative of the INMETRO.

9 Financial aspects

Each participating laboratory is responsible for its own costs for the measurements, transportation and any customs charges as well as any damage that may occur within its country.

10 Insurance of transfer devices

Insurance of transfer devices is decided by agreement among the participants taking account of the responsibility of each participant for any damage in its country.