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Berlin, 31 July, 2006

**Report of the ISO International Observer to the 5<sup>th</sup> Meeting of the CCAUV,  
BIPM, Sèvres, September 2006**

(cf. Draft Agenda of 27/04/06, item 11.2)

**Recent progress of ISO TC 108/SC 3 towards key comparisons and traceability  
in the field of vibration and shock acceleration**

## **1 Introduction**

This report updates the information presented to the 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> meetings of the CCAUV. In the documents CCAUV/99-12, CCAUV/01-05, CCAUV/02-08 and CCAUV/04-06, the International Organization for Standardization outlined the regulations for developing and adopting ISO standards, and presented the standards developed in ISO/TC 108/SC 3 (in Working Group WG 6: *Calibration* in particular).. With the development of the ISO 16063/XX series of standards, ISO/TC 108 responded to the need for upgraded and new standard calibration methods applicable to

- CIPM key comparisons, RMO key comparisons and Supplementary comparisons in the field of vibration and shock measurements
- the reliable and uniform specification of the Calibration and Measurement Capabilities (CMCs) in the branch vibration, published in the BIPM key comparison database (cf. Appendix C of the Mutual Recognition Arrangement MRA) - all NMIs claim their CMCs in the field of vibration and shock acceleration to be in compliance with the relevant ISO standards
- the establishment of traceability chains in the field of vibration and shock (measurands: acceleration, velocity, displacement, angular acceleration, angular velocity and rotational angle).

Upgraded and new and ISO standards and standardization projects focusing on the specification of calibration methods needed at different levels of a traceability chain in the field of vibration and shock have been presented. In the following, the information will be updated outlining the progress achieved since the 4<sup>th</sup> meeting of the CCAUV. The 27<sup>th</sup> meeting of ISO/TC 108/SC 3 held in Mississauga/Canada in August/September 2005 marked a milestone in the ongoing process of developing standards significant for key comparisons and traceability.

## **2 The standard series ISO 16063 “Methods for the calibration of vibration and shock transducers” (state of August 2006)**

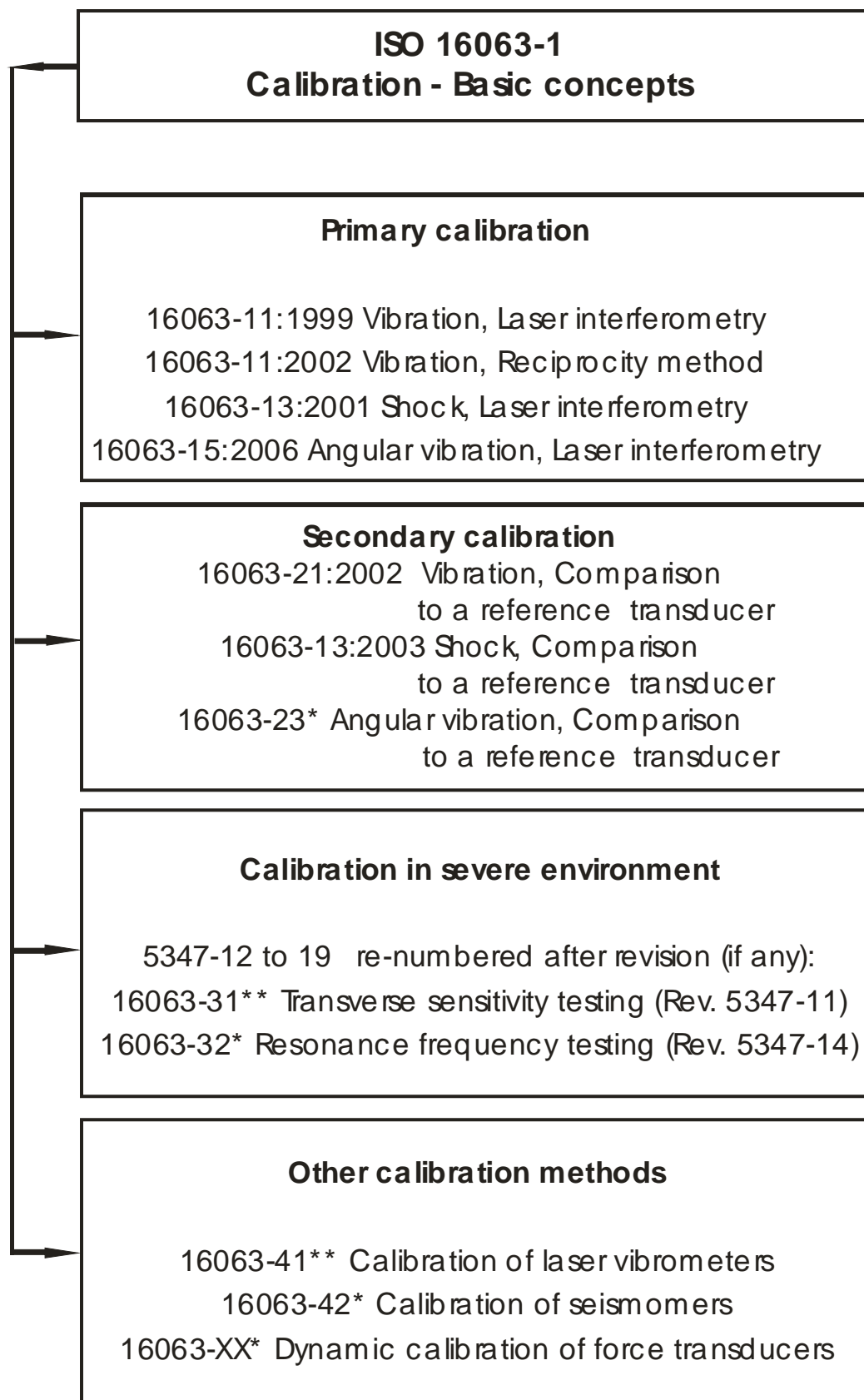
Under the general title "Methods for the calibration of vibration and shock pick-ups", a standard series, ISO 5347, was issued in the period between 1987 and 1997. A

revision of the ISO 5347 series, re-numbered to ISO 16063, was started in 1995, focusing on the specification of upgraded calibration methods needed at different levels of a traceability chain: methods for primary vibration calibration, secondary vibration calibration, primary shock calibration and secondary shock calibration. The re-numbering applies to those standards only which are under revision or are being newly developed. Therefore, the former numbering system (i.e. ISO 5347/XX) is still valid for the standards which have recently been reviewed and confirmed without revision. A survey of the state of the standards and standardization projects of the 16063 series is given in the following.

- (1) **ISO 16063-1: Basic concepts**  
Issued as international standard in 1998, reviewed and confirmed in 2004
- (2) **ISO 16063-11: Primary vibration calibration by laser interferometry**  
Issued as international standard in 1999, reviewed and confirmed in 2004
- (3) **ISO 16063-12: Primary vibration calibration by the reciprocity method**  
Issued as international standard in 2002
- (4) **ISO 16063-13: Primary shock calibration by laser interferometry**  
Issued as international standard in December 2001, reviewed and confirmed in 2006
- (5) **ISO 16063-15: Primary angular vibration calibration by laser interferometry**  
Issued as international standard in 2006
- (6) **ISO 16063-21: Vibration calibration by comparison to a reference transducer**  
Issued as international standard in 2003
- (7) **ISO 16063-22: Shock calibration by comparison to a reference transducer**  
Issued as international standard in 2005
- (8) **ISO 16063-23: Angular vibration calibration by comparison to reference transducers**  
Proposed Work Item (zero stage project) confirmed in 2005
- (9) **ISO 16063-31: Testing of transverse vibration sensitivity**  
Revision of ISO 5347-11:1993 approved in 2004, Working Draft was discussed in 2005, Revised Draft is circulated for comments in 2006
- (10) **ISO 16063-32: Resonance testing**  
Revision of ISO 5347-14:1993 approved in 2004 and confirmed in 2005, preliminary work item in the programme of work, 2006
- (11) **16063-41: Calibration of laser vibrometers**  
New Proposed Work Item ISO/TC 108/SC 3 approved in 2004, Working Draft discussed in 2005, Circulation of new work item proposal together with Revised Draft (Committee Draft) for voting in 2006
- (12) **ISO 16063-42 Calibration of seismometers**  
Preliminary work item in the programme of work, 2004, confirmed in 2005
- (13) **PWI Force transducer calibration**  
Proposed Work Item (zero stage project) approved in 2004, confirmed in 2005, Scope to be discussed in April 2007 (28<sup>th</sup> Meeting of ISO/TC 108/SC 3)

**Figure 1:** State of the standard series ISO 16063 "Methods for the calibration of vibration and shock transducers" (August 2006)

\* Zero-stage project, \*\* Revised Draft



### 3 State of the standard series ISO 5347 “Calibration of vibration and shock pick-ups” (August 2006)

ISO Part	Title	State
5347-0:1987	Basic concepts	revised, 16063-1
5347-1:1993	Primary vibration calibration by laser interferometry	revised, 16063-11
5347-2:1993	Primary shock calibration by light cutting	withdrawn
5347-3:1993	Secondary vibration calibration	revised, 16063-21
5347-4:1993	Secondary shock calibration	revised, 16063-22
ISO 5347-5:1993	Calibration by Earth's gravitation	confirmed 2004
ISO 5347-6:1993	Primary vibration calibration at low frequencies	withdrawn 2004
ISO 5347-7:1993	Primary calibration by centrifuge	confirmed 2004
ISO 5347-8:1993	Primary calibration by dual centrifuge	confirmed 2004
ISO 5347-9:1993	Secondary vibration calibration by comparison of phase angles	withdrawn
ISO 5347-10:1993	Primary calibration by high impact shocks	confirmed 2004
ISO 5347-11:1993	Testing of transverse vibration sensitivity	confirmed 2004, under revision (16063-31)
ISO 5347-12:1993	Testing of transverse shock sensitivity	confirmed 2004
ISO 5347-13:1993	Testing of base strain sensitivity	confirmed 2004
ISO 5347-14:1993	Resonance frequency testing of undamped accelerometers on a steel block	confirmed 2004, revision proposed (16063-32)
ISO 5347-15:1993	Testing of acoustic sensitivity	confirmed 2004
ISO 5347-16:1993	Testing of torque sensitivity	confirmed 2004
ISO 5347-17:1993	Testing of fixed temperature sensitivity	confirmed 2004
ISO 5347-18:1993	Testing of transient temperature sensitivity	confirmed 2004
ISO 5347-19:1993	Testing of magnetic field sensitivity	confirmed 2004
ISO 5347-20:1997	Primary vibration calibration by the reciprocity method	revised, 16063-12
ISO 5347-22:1997	Accelerometer resonance testing - General methods	confirmed 2002

#### 4 Assessment of recent progress

The task of ISO TC 108/SC 3/WG 6 is to develop international standards for the calibration of vibration and shock transducers. Various calibration methods have been specified to cover the different levels in the calibration hierarchy, from the highest accuracy level of primary calibration of a reference transducer in a national metrology institute (NMI) down to the lowest accuracy level of a check calibration of an accelerometer under field conditions. Calibration methods for nearly all kinds of vibration and shock transducers and measuring instruments have been specified. The new ISO standard project "Testing of transverse vibration sensitivity" (Revision of ISO 5347-11:1993, to become ISO 16063-31) specifies different methods using a single-axis vibration generator, a two-axis vibration generator or a triaxial vibration generator. Triaxial vibration excitation allows the transverse sensitivity to be determined with simultaneous excitation of a vibration in the sensitive axis of the transducer, thus simulating application conditions where the transducer is exposed to multi-axial vibration.

ISO TC 108/SC 3 "Use and calibration of vibration and shock measuring instruments" (WG 6 "Calibration" in particular) has continued the great activities to specify upgraded and new standard methods for the calibration of vibration and shock transducers and measuring instruments required to ensure international traceability to the SI units in the field of measurements of accelerations and derived motion quantities. The remarkable progress achieved since the 4<sup>th</sup> CCAUV meeting is reflected in the Sections 2 and 3 of this report. The first international standard for angular vibration calibration, ISO 16063-15 (*Primary angular vibration calibration by laser interferometer*) was a new work item proposal in October 2002 (3<sup>rd</sup> CCAUV meeting) and is now issued as an international standard (ISO 16063-15:2006). The first international standard for the calibration of laser vibrometers, which was a new work item proposal (NWIP) in September 2004 (4<sup>th</sup> CCAUV meeting) has achieved in 2006 the Committee Draft stage circulated for voting. With the specification of methods for the calibration of laser vibrometers (to become ISO 16063-41), a documentary basis will be established to ensure traceability for vibration measurements by laser interferometry.

For primary vibration calibration by laser interferometry at NMI level, ISO 16063-11:1999 had extended the frequency range (0.4 Hz to 10 kHz) and included absolute phase shift measurement. For modulus and phase calibration of rectilinear vibration transducers in the same frequency range at lower levels of the traceability chain ISO 16063-21:2003 had specified appropriate methods. Recent experimental investigations and comparisons of specific calibration methods specified in parts 11 and 21 of ISO 16063 have demonstrated that they are capable for higher frequencies. This has been taken into account by their adaptation and specification for calibrations of laser vibrometers up to 50 kHz (Revised draft of ISO 16063-41).

A similar progress has been achieved with the pair of ISO standards for shock calibration by laser interferometry (ISO 16063-13:2001) and by comparison to a reference transducer (ISO 16063-22:2005) which are specified for accelerations up to 100 km/s<sup>2</sup> traceable to primary methodologies but proved to be applicable also at higher shock accelerations (e.g. 1000 km/s<sup>2</sup>).

ISO 16063-15:2006 specifies primary angular vibration calibration by laser interferometry (magnitude and phase shift) in the frequency range from 0.4 Hz to 1.6 kHz. The corresponding project for angular vibration calibration by comparison to a reference transducer is still on the preliminary stage.

## 5 Applications and conclusions

Using the ISO methods specified, hierarchies of measurement standards (traceability chains) have been established and are operated by national metrology institutes (NMIs) as well as accredited and non-accredited calibration laboratories in compliance with the upgraded and new ISO standards. The primary calibration methods and techniques developed at PTB in compliance with the ISO standards are used in Germany and Europe on the basis of three agreed EUROMET projects providing traceability for sinusoidal acceleration (Ref.-No. 198; ISO 16063-11), angular acceleration (No. 284; ISO 16063-15) and shock acceleration (No. 368; ISO 16063-13); cf. [www.EUROMET.org](http://www.EUROMET.org). Traceability is provided by primary calibrations of reference or transfer standards which are later used in accredited calibration laboratories (calibration services) in Germany and other countries. The upgraded calibration capabilities achieved in accredited calibration laboratories are documented in [www.DKD.info](http://www.DKD.info), for example. Moreover, several European NMIs are linked-up to PTB in accordance with the agreed EUROMET Projects providing traceability (e.g. Ref.-No. 198).

For key comparisons at the CIPM and RMO levels and supplementary comparisons in the field of vibration and shock measurements (quantity of acceleration), the methods specified in the relevant ISO standards are used - preferably primary vibration calibration by laser interferometry as specified in ISO 16063-11 and secondary calibration by comparison to a reference transducer as specified in ISO 16063-21.

The calibration and measurement capabilities (CMCs) offered in Appendix C of the Mutual Recognition Arrangement MRA (see. <http://www.bipm.org>, Key Comparison Database) for the branch vibration are based on the up-to-date ISO standard methods.

There is a current jurisdictional conflict between ISO and IEC regarding accelerometer calibration standards that is under study by the ISO Central Secretariat (CS) and IEC. Their findings will be reported at the next (i.e. 6<sup>th</sup>) Meeting of the CCAUV. The ISO/TC 108 has invited participation by IEC/TC 47 experts in new work items of interest to both groups.