



Strål  
säkerhets  
myndigheten

Swedish Radiation Safety Authority

# Calibration of activity meters – metrological traceability

MedInspector 2018 6-8 November, Stockholm, Sweden

Linda Persson  
2018-11-06

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- Legal metrology
- Metrological traceability
  
- Calibration of activity meters
  - examples of calibration certificates for a reference source
  - what do we need to establish metrology traceability for a activity meter

- ➔ Legal metrology
- ➔ Metrological traceability



			
IEC	ISO	UNIDO-BIPM	ILAC-IAF

# Metrological traceability

**Bureau**  
International des  
Poids et  
Mesures


BIPM  
(Bureau International des  
Poids et Mesures)

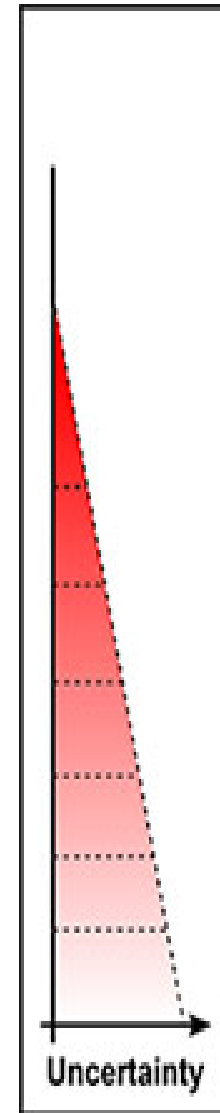
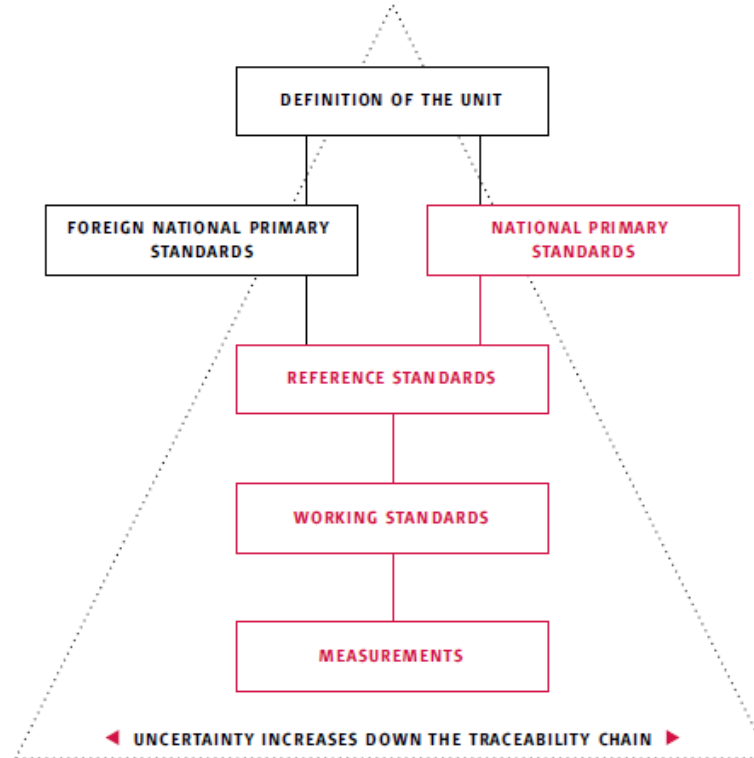
National metrology  
institutes or designated  
national institutes

Calibration laboratories,  
often accredited

Industry, academia,  
regulators, hospitals

End users

 The national  
metrological infrastructure



Organisation Internationale de Métrologie Légale  
International Organization of Legal Metrology

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# How to establish metrological traceability in nuclear medicine

- Calibrate activity meter at a NMI or accredited laboratory
- Use reference source with calibration certificate and make a calibration on-site (hospital)



# A calibration report from NMI or accredited method follows EN ISO/IEC 17025:2017 (7.8.2.1) /2/:

- a) a title (e.g. “Calibration Certificate”);
- b) the name and address of the laboratory;
- c) the location of performance of the laboratory activities, including when performed at a customer facility or at sites away from the laboratory’s permanent facilities, or in associated temporary or mobile facilities;
- d) unique identification that all its components are recognized as a portion of a complete report and a clear identification of the end;
- e) the name and contact information of the customer;
- f) identification of the method used;
- g) a description, unambiguous identification, and, when necessary, the condition of the item;
- h) the date of receipt of the test or calibration item(s), and the date of sampling, where this is critical to the validity and application of the results;
- i) the date(s) of performance of the laboratory activity;
- j) the date of issue of the report;
- k) reference to the sampling plan and sampling method used by the laboratory or other bodies where these are relevant to the validity or application of the results;

- l) a statement to the effect that the results relate only to the items tested, calibrated or sampled;
- m) the results with, where appropriate, the units of measurement;
- n) additions to, deviations, or exclusions from the method;
- o) identification of the person(s) authorizing the report;
- p) clear identification when results are from external providers.

In addition to this, a calibration certificate shall additionally include (EN ISO/IEC 17025:2017) (7.8.4.1):

- a) the measurement uncertainty of the measurement result presented in the same unit as that of the measurand or in a term relative to the measurand (e.g. percent);
- b) the conditions (e.g. environmental) under which the calibrations were made that have an influence on the measurement results;
- c) a statement identifying how the measurements are metrologically traceable
- d) the results before and after any adjustment or repair, if available;
- e) where relevant, a statement of conformity with requirements or specifications
- f) where appropriate, opinions and interpretations

- Standard EN/ISO 17034:2016 “General requirements for the competence of reference material producers” may contain additional requirements for the reference material produces



## **Review a radioactive reference source calibration certificate**

1. Accreditation Body Symbol (ISO 17025 or ISO17034 (CRM)).
2. Measurement result
3. Measurement Uncertainty
4. The units of measurements (should be SI)
5. Identification of the method used
6. Description of the Reference Standard
7. Updated sources for tabulated values( $T_{1/2}$ , energies...)
8. Statement of traceability
9. Environmental conditions



**Eckert & Ziegler**  
Isotope Products

**Medical Imaging Laboratory**  
24937 Avenue Tibbitts Valencia, California 91355  
Tel 661-309-1010 Fax 661-257-8303

**Industrial Gauging and Medical Imaging Laboratory**  
1800 North Keystone Street Burbank, California 91504  
Tel 661-309-1010 Fax 661-257-8303

**NIST TRACEABLE CERTIFICATE  
GAMMA STANDARD SOURCE**

**RADIONUCLIDE:** Co-57  
**HALF LIFE:** 271.79 ± 0.09 days  
**CATALOG NO:** RV-057-10M  
**SOURCE NO:** 1639-85-4

**REFERENCE DATE:** 1 May 13, 12:00 PST  
**CONTAINED RADIOACTIVITY:** 10.29 mCi  
**CONTAINED RADIOACTIVITY:** 380.7 MBq **2, 4**

**SOURCE DESCRIPTION:**  
CAPSULE TYPE: RV (27 ml polyethylene bottle)  
NATURE OF ACTIVE DEPOSIT: Co-57 dispersed in an epoxy matrix  
ACTIVE DIAMETER/VOLUME: Approx. 20 ml  
BACKING: Plastic  
COVER: Plastic

**RADIOIMPURITIES:**  
Co-56 = 0.0348%; Co-58 = 0.00962% on 1 May 13.

**METHOD OF CALIBRATION:**  
This source was assayed in a pressurized well-type ionization chamber.

**UNCERTAINTY OF MEASUREMENT:**  
TYPE B (SYSTEMATIC) UNCERTAINTY: ± 3.0%  
TYPE A (RANDOM) UNCERTAINTY: ± 0.0% **3**  
UNCERTAINTY IN ALIQUOT WEIGHING: ± 0.0%  
TOTAL UNCERTAINTY AT THE 99% CONFIDENCE LEVEL: ± 3.0%

**NOTES:**

1. See reverse for leak tests performed on this source.
2. IPL participates in an NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Material (As in NRC Regulatory Guide 4.15).
3. Nuclear data was taken from IAEA-TECDOC-619, 1991. **7**
4. This source has a working life of 18 months.
5. ANSI N542-1977 Classification: ANSI 77C22212.

**LAB BOOK-PAGE:** 1639-85

*Donald James Knudsen* | 9-Feb-13  
SIGNATURE | DATE

ISO 13485 CERTIFIED **1**

EC REP Authorized Representative Eckert & Ziegler Nuclitec GmbH Gieselweg 1 38110 Braunschweig Germany  
Tel: +49 (0) 5307 9320 Fax: +49 (0) 5307 932 293

CE

1. No Accreditation Body Symbol !

5. Could have been a standard method (ISO...) or description of the method

6?

9?

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2018-11-06



# DEUTSCHER KALIBRIERDIENST **DKD**

Kalibrierlaboratorium für Messgrößen der Radioaktivität  
*Calibration laboratory for measurements of radioactivity*

Akkreditiert durch die / accredited by the

Akkreditierungsstelle des DKD bei der

PHYSIKALISCH-TECHNISCHEN BUNDESANSTALT (PTB)



Deutscher  
 Akkreditierungs-  
 Institut  
**DAkk**  
 DKD-K-06501

AEA Technology QSA GmbH

Gieselweg 1

38110 Braunschweig, Germany

Phone +49 5307 932-0, fax +49 5307 932-194

Source No. KF 939

010272

DKD-K-

06501

02-03

Kalibrierschein  
*Calibration Certificate*

Kalibrierzeichen  
*Calibration label*

Gegenstand  
*Object*

**Gamma Reference Source**

Dieser Kalibrierschein dokumentiert die Rückführung auf nationale Normale zur Darstellung der Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI).

Hersteller  
*Manufacturer*

**AEA Technology QSA GmbH**

Der DKD ist Unterzeichner der multilateralen Übereinkommen der European co-operation for Accreditation (EA) und der International Laboratory Accreditation Cooperation (ILAC) zur gegenseitigen Anerkennung der Kalibrierscheine.

Typ  
*Type*

**BDR562**

Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich.

Strahler-Nr.  
*Source number*

**KF 939**

*This calibration certificate documents the traceability to national standards, which realize the units of measurement according to the International System of Units (SI).*

Auftraggeber  
*Customer*

**HUDDINGE UNIVERSITETSSJUKHUS  
 14186 HUDDINGE  
 SCHWEDEN**

*The DKD is signatory to the multilateral agreements of the European co-operation for Accreditation (EA) and of the International Laboratory Accreditation Cooperation (ILAC) for the mutual recognition of calibration certificates.*

Auftragsnummer  
*Order No.*

**CO 49337**

Anzahl der Seiten des Kalibrierscheines  
*Number of pages of the certificate*

**2**

Datum der Kalibrierung  
*Date of calibration*

**1 April 2002**

*The user is obliged to have the object recalibrated at appropriate intervals.*

Dieser Kalibrierschein darf nur vollständig und unverändert weiterverbreitet werden. Auszüge oder Änderungen bedürfen der Genehmigung sowohl der Akkreditierungsstelle des DKD als auch des ausstellenden Kalibrierlaboratoriums. Kalibrierscheine ohne Unterschrift und Stempel haben keine Gültigkeit.

*This calibration certificate may not be reproduced other than in full except with the permission of both the Accreditation Body of the DKD and the issuing laboratory. Calibration certificates without signature and seal are not valid.*

Stempel Seal	Datum Date	Leiter des Kalibrierlaboratoriums Head of the calibration laboratory	Stellvertreter Deputy	Bearbeiter Person in charge
	18 March 2002	Dr. Thieme	Schott	U. Wille Lehmacher / Linke / Schott / Schüler



Linda Persson  
 2018-08-28

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## Gamma Reference Source

Source no.  
 Drawing  
 Nuclide  
 Activity  
 Reference date  
 Leakage and contamination test  
 Date of wipe test  
 Measuring method

KF 939  
 VZ-505/1  
 Barium-133  
 8.23 MBq  
 1 April 2002 at 12.00 GMT  
 Wipe test according to ISO 9978.  
 14 March 2002

The activity of the source was determined by comparison with a reference source of the same construction using a NaI-detector with MCA.

Traceability

Additional to the direct traceability to the PTB through the DKD this product complies with the requirements for traceability to NIST specified in the American National Standard "Traceability of Radioactive Sources to the NIST and Associated Instrument Quality Control (ANSI N42.22-1995)". As a requirement of the ANSI N42.22-1995 AEA Technology QSA GmbH participates in the NEI/NIST Measurements Assurance Program of the Nuclear Power Industry.

Uncertainty

The relative uncertainty of the activity is 3 %.  
 The reported uncertainty, determined according to the DKD-3 report is based on the standard uncertainty multiplied by a coverage factor of k = 2, providing a level of confidence of 95 %. (Ref. NIST Technical Note 1297/"Guide to the Expression of Uncertainty in Measurement" ISO Guide, 1995)

Radioactive impurities

Related to Ba-133 (equal 100 %) the following radioactive impurities were detected: none

Quality assurance system

The quality assurance system of AEA Technology QSA GmbH was certified by Lloyd's Register Quality Assurance (LRQA) according to ISO 9001, issue 1994.

Remark

1. ISO9001 not  
 ISO 17025

7?  
 9?

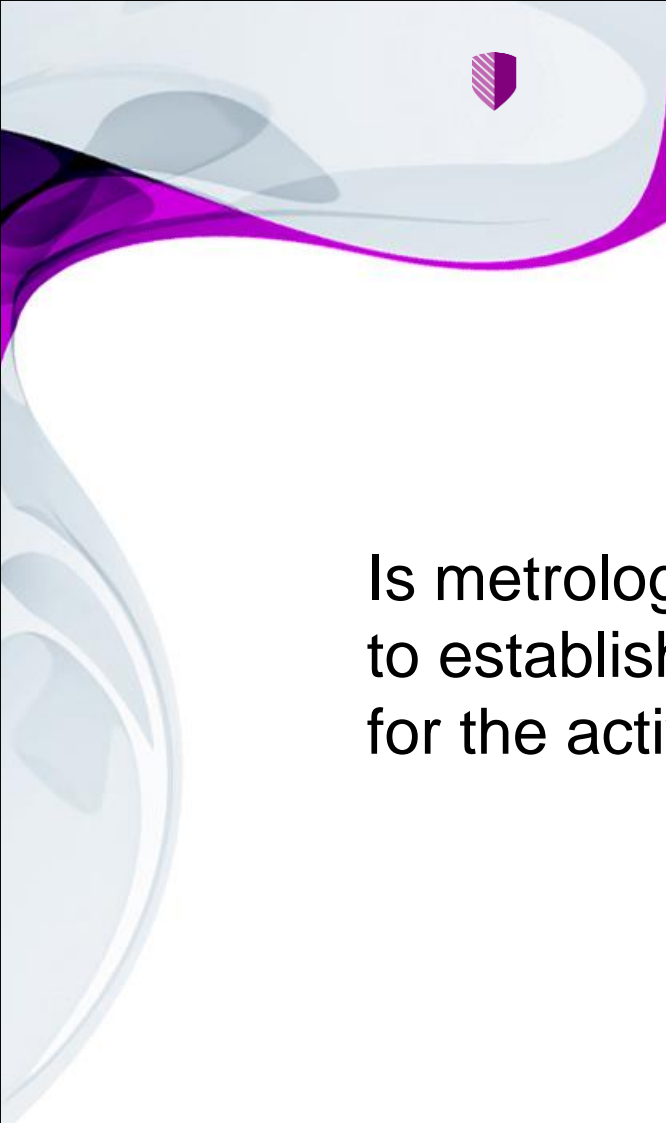
010272  
 DKD-K-06501  
 02-03



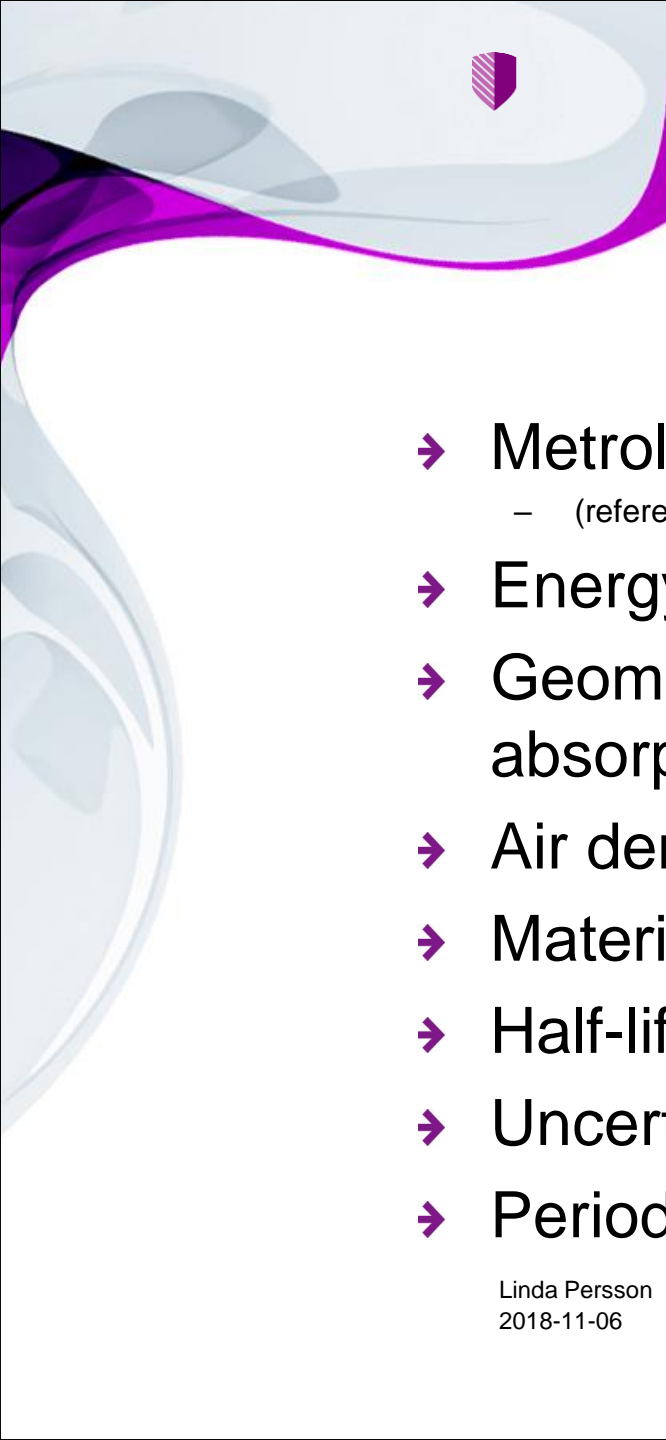
5, 6?

8

3

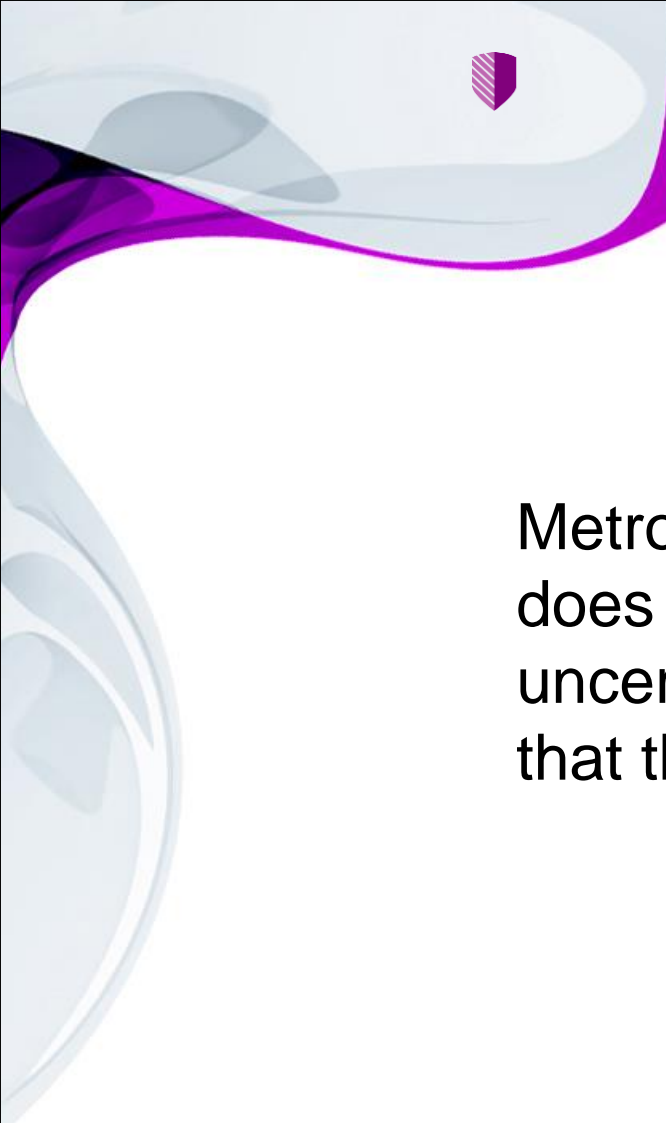


Is metrology traceability for the activity meter enough to establish metrology traceability with uncertainties for the activity measurements?



## **Metrology traceability for a reference source is not enough for establish metrological traceability for an activity meter, we also need to...**

- ➔ **Metrology traceability of all used quantities**
  - (reference source, volume, weight, half-life, decay paths, temperature, pressure...)
- ➔ **Energy dependency,**
- ➔ **Geometrical dependency of vial's and self absorption** (syringe Vs vials)
- ➔ **Air density**
- ➔ **Material of vial's**
- ➔ **Half-life**
- ➔ **Uncertainty budget**
- ➔ **Periodical calibration**



Metrology traceability of a measurement result does not ensure that the measurement uncertainty is adequate for a given purpose or that there is an absence of mistakes.

