



Regulatory Document

Requirements for Gamma Radiation Survey Meter Calibration

A Regulatory Guide

Effective date: January 9, 1995

PREFACE

The Atomic Energy Control Board has three levels of Regulatory Documents, graduated in terms of their rigidity of application.

Level 1: Regulatory Guides

This is the most flexible form of regulatory document, providing advice or guidelines on certain aspects of the regulatory process.

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These contain firm requirements and guidelines for compliance. However, the AECB may allow variations, or consider alternative means of attaining the same objectives where a satisfactory case is made.

Level 3: Regulations

These are instruments by which the AECB establishes prohibitions, rights, obligations and powers pursuant to the *Atomic Energy Control Act*. Regulations possess the full force of law; they leave little room for interpretation.

All Regulatory Documents are initially issued in draft form as Consultative Documents, for comments by the public, special interest groups and those potentially affected by the content such as licensees and their employees.

Suggestions for new Regulatory Documents and for improvement to those that exist are encouraged and should be directed to the AECB Office of Public Information, as should requests for technical information on and interpretation of Regulatory Documents, if a subject matter specialist is not specified in the text.

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NOTICE

A draft of this Regulatory Document was issued for public comment as a Consultative Document (C-117) on November 28, 1990. On completion of the comment review and text revision process, the content was made effective on January 9, 1995.

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TABLE OF CONTENTS

	page
1. INTRODUCTION AND SCOPE.....	1
2. DEFINITIONS	1
3. RESPONSIBILITY FOR SURVEY METER CALIBRATION	2
4. SURVEY METER CALIBRATION REQUIREMENTS	2
4.1 Calibration Procedure Documentation	2
4.2 Survey Meter Pre-Calibration Check.....	3
4.3 Physical and Environmental Requirements for Jigs and Survey Meters.....	3
4.4 Requirements for Calibration Sources.....	3
4.5 Requirements for Survey Meter Calibration.....	3
4.6 Requirements for Record Completion.....	4
4.7 Frequency	4
5. REQUIREMENTS FOR RECORD KEEPING	4
APPENDIX — CERTIFICATES AND FORMS	5
Gamma Radiation Survey Meter Calibration Certificate.....	6
Calibration Sticker.....	7
Gamma Radiation Survey Meter Notification of Failure to Calibrate	8

Requirements for Gamma Radiation Survey Meter Calibration

1. INTRODUCTION AND SCOPE

This guide describes the minimum requirements for calibrating a portable gamma radiation survey meter with a beam of radiation from a known calibration source. If an alternative method of calibration is to be used, the calibrator shall make a written request to the Atomic Energy Control Board (AECB) that describes the calibration method to be used, and request the Board's permission to use that method in place of the requirements contained in this guide.

This guide explains:

- (a) the responsibilities of a licensee who calibrates its own survey meters;
- (b) the responsibilities of a licensee who contracts an approved calibration agency to calibrate its survey meters;
- (c) the responsibilities of an approved calibration agency;
- (d) the requirements for survey meter calibration and the supporting documentation;
- (e) the requirements for record keeping;
- (f) a calibration certificate, a calibration sticker, and a notification of failure to calibrate form.

The SI unit of dose equivalent, the sievert (Sv), is used throughout this guide, and dose rates are quoted in sieverts per hour (Sv/h) with an appropriate prefix.

It is realized that:

- (a) some of the very old makes of survey meters are marked in units of exposure rate (i.e. roentgens per hour [r/h or R/h]), and are calibrated by the manufacturer in roentgens per hour;
- (b) some of the old makes of survey meters are marked in units of rem per hour (rem/h), but are actually calibrated by the manufacturer in roentgens per hour. The historically accepted equivalence that 1 roentgen is approximately equivalent to 1 rad is equivalent to 1 rem for gamma radiation being utilized;
- (c) some of the new makes of survey meters can, by choice of model, be marked in units of roentgens per hour, rem per hour or sieverts per hour. Also that some of the new makes of survey meters can, by selection, display in units of roentgens per hour, rem per hour or sieverts per hour. Irrespective of the units marked or displayed many of the survey meters are still calibrated by the manufacturers in roentgens per hour and utilize the historical equivalence described in paragraph (b) and the equivalence of 1 rem to 10 mSv;
- (d) some survey meters actually do measure, display and are calibrated in units of dose equivalent rates of rem per hour and sieverts per hour.

Taking the above into consideration the AECB is prepared to consider any survey meter marked in units of roentgens per hour, rad per hour, rem per hour, grays per hour and sieverts per hour, with appropriate prefixes.

The method of calibration required pursuant to subsection 4.1, shall include an explanation of any equivalence or approximate equivalence between radiation units. Appropriate references should be provided, such as manufacturer's data. If sophisticated depth dose equivalent calibrations are performed, reference to appropriate publications by the International Commission of Radiation Units and Measurements (ICRU 39 and 43) and the International Commission on Radiological Protection (ICRP 51) would also be expected.

2. DEFINITIONS

In this guide:

- “accuracy” with respect to a survey meter, means a measure of the difference between the observed dose rate and the expected dose rate during calibration and does not include the energy response of the instrument; (*exactitude*)
- “approved agency” means any person or company who is authorized by the AECB to provide gamma radiation survey meter calibration services; (*organisme accrédité*)
- “calibration” means the determination of the response of an identified instrument when exposed to the radiation output of a defined source under defined conditions; (*étalonnage*)

“calibration distance” means the distance from the centre of the calibration source to the centre of the sensitive volume of the detector when both source and survey meter are correctly set up on the calibration jig; (*distance d'étalonnage*)

“calibrator” is a licensee or agency that calibrates gamma radiation survey meters and, by inference, is approved or is seeking approval; (*étalonneur*)

“directional dependence” means a change in instrument response with respect to orientation of the instrument for constant exposure rate, excluding geotropism; (*dépendance directionnelle*)

“energy response” means a change in instrument response with respect to radiation energy for constant exposure rate; (*réponse d'énergie*)

“expected dose rate” means a dose rate calculated from a knowledge of the calibration source and calibration distance, including where appropriate the contribution from local background radiation. This dose rate has its own uncertainty which is associated with the uncertainties of activity ($\pm 10\%$), decay correction ($\pm 1\%$), and calibration distance ($\pm 2\%$); (*débit de dose prévu*)

“geotropism” means a change in instrument response with a change in instrument orientation as a result of gravitational effects; (*géotropisme*)

“implicitly traceable” means traceability to a national or international standards laboratory that assumes the continuing measuring competence of a source supplier, if that supplier carries out regular traceability exercises or intercomparisons with national or international standards laboratories (see NCRP Report 58, 2nd edition, 1985); (*retraçable implicitement*)

“uncertainty” means an informed estimate of a known inaccuracy in a measurement process; (*incertitude*)

“written assessment” means any exchange of correspondence between the AECB and a licensee, or the AECB and an agency, concerning the requirements of this guide. (*évaluation écrite*)

3. RESPONSIBILITY FOR SURVEY METER CALIBRATION

Licensees who calibrate survey meters themselves shall be responsible for obtaining AECB approval for their calibration services.

Licensees who contract an approved agency to calibrate their survey meters shall normally only be responsible for the record-keeping requirements of section 5 of this guide.

Approved agencies who calibrate survey meters for licensees are responsible for obtaining AECB approval for their calibration services. Agencies wishing to be approved shall make a written request to the AECB for inclusion on the approved list. The AECB will maintain, and provide upon request, a list of approved agencies. Only those agencies listed will be considered acceptable to perform calibrations for AECB licensees. The AECB will inspect the approved agencies periodically and revise the list as necessary. If a previously approved agency is subsequently found to be in non-compliance, then any affected licensees will be notified. Where possible, notification will be sent to each individual licensee, or failing this, by wider circulation in the AECB quarterly journal *Reporter*, or other convenient method.

Licensees and approved agencies may be inspected for compliance with this guide during any AECB physical inspection, or by written assessment, or both.

4. SURVEY METER CALIBRATION REQUIREMENTS

4.1 Calibration Procedure Documentation

Before calibrating any specific make and model of survey meter, the calibrator shall have available for inspection and assessment a documented calibration procedure consisting of:

- (a) a general description of the method of calibration;
- (b) an identification and proof of verification of uncertainties associated with the jig, the source, attenuators, and decay correction which are associated with the total uncertainty of the calibration;
- (c) step-by-step procedures, preferably including manufacturers' manuals, to show that sufficient information about the survey meter is available to operate, to perform pre-calibration checks and to calibrate, including any necessary adjustments in the last two cases, and
- (d) calibration certificates, calibration stickers, and notification of failure to calibrate forms.

4.2 Survey Meter Pre-Calibration Check

Before calibration, each survey meter shall have a pre-calibration check that consists of:

- (a) a battery check to ensure a satisfactory voltage can be maintained throughout the calibration;
- (b) a verification of operating voltage, and
- (c) a comprehensive functional check on all ranges of the features of the survey meter.

4.3 Physical and Environmental Requirements for Jigs and Survey Meters

(a) The beam calibrator jig shall be located:

- (i) to minimize radiation scatter and be at least 1 m from the floor, the ceiling, and from any wall. The distance between any scattering object and the source shall be at least 0.5 m,
- (ii) in an area free of interference from sources of ionizing radiation other than the calibration source, and
- (iii) in an area free of interference from electrostatic, electrical and magnetic fields, and from non-ionizing radiation, such as radio frequency and microwave.

(b) The survey meter to be calibrated shall:

- (i) be positioned on the jig to minimize bias due to geotropism, directional dependence, and non-uniformity of the source radiation beam across and through the detector volume, and
- (ii) have any beta window or shield in the optimum position (normally closed) for best (i.e. flattest) energy response.

The uncertainty in calibration distance shall not be greater than 2%* and shall be the arithmetic sum of the uncertainty of the jig distance scale, the uncertainty in physical placement and repositioning of the survey meter, the uncertainty in location of the source centre when on the jig, and the uncertainty of the centre of the sensitive volume of the survey meter detector.

The survey meter to be calibrated shall have achieved equilibrium with the temperature, pressure and humidity of the local calibration area. These environmental parameters should be noted and shall be within the approved range as specified by the manufacturer of the survey meter. It is recommended that instruments are calibrated at about 20°C (68°F) and 101.3 kPa (1 atmosphere), or at the anticipated operational parameters.

4.4 Requirements for Calibration Sources

It is preferable to use the same reference isotope as the manufacture for the calibration source, especially if the manufacturer's specified energy response is to be assumed. Whatever isotope is used, the dose rate compared to energy response of the survey meter shall be known and shall be within 30% of the true dose rate over the energy spectrum of interest.

The calibration source activity (or exposure rate) shall be known to an uncertainty of not greater than $\pm 10\%$. This uncertainty shall include attenuators (used singly or in combination), if they are an integral part of the source assembly. A calibration source certificate shall be available for inspection, and as a minimum the source shall be implicitly traceable through a source supplier to a national or international standard.

The calibration source activity shall be corrected for decay at a frequency to ensure its activity is within 1% of its true value.

4.5 Requirements for Survey Meter Calibration

Each survey meter shall be calibrated up to its highest range or the 10 mSv/h range, whichever is lower. The manufacturer's recommended calibration method, if any, shall be followed, and the calibration shall be verified

* It is estimated that the minimum value of the uncertainty in calibration distance is about 0.5 cm, which equates to 25 cm as the minimum calibration distance (within the 2% criterion). At the minimum distance, the reference source should be capable of producing at least 8 mSv/h which equates to a cesium-137 source of 5.7 GBq (150 mCi).

at about 20 to 25%* and 75 to 80% of the measurement of each range or decade. Measurement shall be recorded before and after any necessary (or preferred) calibration adjustments and a survey meter shall be considered adequately calibrated when each observed measurement is within $\pm 20\%$ of the expected dose rate.

Measurements above 10 mSv/h need not be calibrated, but each range shall be checked to ensure response and, as far as practicable, by decreasing calibration distance the appropriate increasing dose rate response shall be checked.

4.6 Requirements for Record Completion

Immediately following calibration the calibrator shall complete a calibration certificate, and complete and affix a durable calibration sticker to the survey meter. The calibrator shall retain a copy of the calibration certificate and return the original certificate with the survey meter to the user.

If a survey meter fails to meet criteria for calibration, the calibrator shall complete a notification of failure to calibrate form. The calibrator shall retain a copy of the notification and return the original notification with the survey meter to the user. If requested to do so, a calibrator may repair a survey meter before returning to the user. Subsequent to repair, a survey meter shall be recalibrated.

4.7 Frequency

The frequency for survey meter calibration is specified in the *Atomic Energy Control Regulations* for industrial radiography licences and in the licence conditions for other applicable radioisotope licensed activities.

5. REQUIREMENTS FOR RECORD KEEPING

The minimum requirements for survey meter calibration records are:

- (a) an adequate record shall be a calibration certificate as shown in the Appendix;
- (b) calibration certificates shall be maintained for three years by licensees and calibration agencies;
- (c) agencies shall retain copies of calibration certificates and send originals to licensees, and
- (d) licensees shall retain originals of calibration certificates.

* Typical commercial attenuator sets of 0.1, 0.1 and 0.25 can be utilized to produce dose rates of 8, 2, 0.8, 0.2, 0.08, 0.02 mSv/h without change of location of instrument, which is ideal for calibrating the bottom three scales of most survey meters.

CERTIFICATES AND FORMS

Calibrators are free to design their own "calibration certificate", "calibration sticker" and "notification of failure to calibrate" form, but such documents shall contain the information specified herein.

Attached are examples of:

- (a) gamma radiation survey meter calibration certificate*;
- (b) calibration sticker, and
- (c) gamma radiation survey meter notification of failure to calibrate.

*** When completing the calibration certificate:**

- (a) any pre-calibration checks that are not applicable to a specific make and model shall be entered as "N/A";
- (b) appropriate units (preferably SI units) shall be entered when recording such data as activity, temperature, pressure and humidity;
- (c) The "Observed Dose Rate" column of the Calibration Table shall show:
 - (i) one column of figures if a survey meter is within criteria and is returned as found (i.e., without adjustment), and
 - (ii) two columns of figures listing the as found (pre-calibration) measurements, and as returned (post-calibration) measurements if adjustments are made for any reason;
- (d) "Summary of Findings" shall:
 - (i) include statements certifying that the survey meter is within the criteria (as specified in this AECB Regulatory Guide), quantifying the measured accuracy and noting any uncalibrated ranges,
 - (ii) note any dose rates with respect to any constancy check source provided by the licensee, and
 - (iii) note and highlight any as found measurements outside criteria. The calibrator should notify the licensee forthwith of these outlying values. The calibrator shall record under "Summary of Findings" the name of the person notified, the means (telephone or fax number) to make the notification, and the time and date of the notification.

**GAMMA RADIATION SURVEY METER
CALIBRATION CERTIFICATE**

Calibrator

Name
Address
..... Telephone (.....)

Licensee

Name
Telephone (.....) AECB Licence Number

Survey Meter

Make Model
Serial Number Type of Detector

Method of Calibration

Calibration System Identification

Make Model
Serial Number Isotope

Activity (or exposure rate) on
(year/month/day)

Pre-Calibration Checks

Battery Zero Operating Voltage
Alarm Other(s)
Temperature Pressure Humidity

Calibration

Range	Expected Dose Rate	Observed Dose Rate		Units	Notes
		Pre-Calibration	Post-Calibration		

Summary of Findings:

Calibrated on by
(year/month/day) (print name) Signature

CALIBRATION STICKER

CALIBRATION STICKER	
Calibrator Name	
Calibration of Serial Number	
on	by
(year/month/day)	(initials)

**GAMMA RADIATION SURVEY METER
NOTIFICATION OF FAILURE TO CALIBRATE**

Calibrator

Name

Address

..... Telephone ()

Licensee

Name

Telephone ()..... AECB Licence Number

Survey Meter

Make Model

Serial Number Type of Detector

The above survey meter failed to meet the Atomic Energy Control Board calibration criteria.

Reason for failure to calibrate:

Tested on by Signature

(year/month/day) (print name)