

FOREWORD

Occupational radiation protection is a major component of the support for radiation safety provided by the International Atomic Energy Agency to its Member States. The objective of the IAEA Occupational Protection Programme is to promote an internationally harmonized approach to optimizing occupational radiation protection through the development and application of guidelines for restricting radiation exposures in the workplace and for applying current occupational radiation protection techniques.

Requirements for occupational radiation protection are presented in Appendix I of the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (BSS), co-sponsored by the Food and Agriculture Organization of the United Nations (FAO), the IAEA, the International Labour Organization (ILO), the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development (OECD/NEA), the Pan American Health Organization (PAHO) and the World Health Organization (WHO).

Occupational exposure to ionizing radiation can occur in industry, medical institutions, research establishments, universities and nuclear fuel cycle facilities. Adequate radiation protection for workers is an essential requirement for the safe and acceptable use of radiation, radioactive materials and nuclear energy. Guidance on the application of the requirements of the BSS to occupational protection is given in three interrelated Safety Guides: Occupational Radiation Protection (RS-G- 1.1); Assessment of Occupational Exposure due to External Sources of Radiation (RS-G-1.3); Assessment of Occupational Exposure due to Intakes of Radionuclides (RS-G- 1.2).

This Safety Report provides guidance on the establishment and operation of calibration facilities for radiation monitoring instruments. It reflects the current internationally accepted principles and recommended practices in calibration procedures, taking into account of the major changes and developments that have occurred over the past decade.

This publication is the result of the efforts of several experts who have provided material and drafted and reviewed the text. The IAEA gratefully acknowledges the assistance of all these contributors. The IAEA officers responsible for the preparation of this report were R. Griffith and R. Ouvrard.

CONTENTS

1.	INTRODUCTION	1
1.1.	Background	1
1.2.	Scope	1
1.3.	Purpose of calibration	2
2.	TERMINOLOGY, QUANTITIES AND UNITS	3
2.1.	Terminology	3
2.2.	Operational quantities and quantities used for the calibration of surface contamination monitoring equipment	8
2.3.	Operational quantities and phantoms for dosimeters and dose rate meters	9
2.4.	Other quantities	17
3.	FUNDAMENTALS OF CALIBRATION	21
3.1.	Calibration and tests	21
3.2.	Reference conditions and standard test conditions	22
3.3.	Traceability	25
3.4.	Determination of the calibration factor and of the response by a reference instrument	28
3.5.	Determination of the calibration factor and the response in a known radiation field (calibration method 4)	39
3.6.	Additional considerations for calibrations	40
3.7.	Intercomparison programmes	42
3.8.	Records and certificates	45
4.	CALIBRATION OF PHOTON MEASURING INSTRUMENTS	45
4.1.	General	45
4.2.	Conversion coefficients for ISO reference photon radiations	48
4.3.	Reference instruments	60
4.4.	Measurements of the characteristics and calibration of radiation fields	65
4.5.	Facilities	76

- 5. CALIBRATION OF BETA MEASURING INSTRUMENTS 82
 - 5.1. Calibration quantities and conversion coefficients 82
 - 5.2. Reference beta radiations 84
 - 5.3. Reference standards and calibration of radiation fields 88
 - 5.4. Facilities 91

- 6. CALIBRATION OF NEUTRON MEASURING INSTRUMENTS 92
 - 6.1. Calibration quantities and conversion coefficients 92
 - 6.2. Reference neutron radiations 93
 - 6.3. Facilities 96
 - 6.4. Reference instruments 99
 - 6.5. Radiation fields calibrations 101
 - 6.6. Additional recommendations for calibrating
survey meters 107

- 7. CALIBRATION OF SURFACE CONTAMINATION MONITORING
INSTRUMENTS 108
 - 7.1. General 108
 - 7.2. Reference standard sources 110
 - 7.3. Instrument calibration procedures 113

- 8. MEASUREMENT UNCERTAINTIES 115
 - 8.1. Introduction 115
 - 8.2. General considerations on errors and uncertainties 115
 - 8.3. Type 'A' standard uncertainties 117
 - 8.4. Type 'B' standard uncertainties 118
 - 8.5. Combined uncertainties and expanded uncertainties 120
 - 8.6. Propagation of uncertainties 120
 - 8.7. Definitions 122

- APPENDIX I. AN EXAMPLE OF DETERMINING THE
OVERALL UNCERTAINTIES FOR THE
CALIBRATION OF AN INSTRUMENT 125

APPENDIX II. AN EXAMPLE OF DETERMINING THE CALIBRATION FACTOR, N_p , OF AN AMBIENT DOSE EQUIVALENT RATE METER — CALIBRATION WITH REFERENCE INSTRUMENT WITHOUT MONITOR (CALIBRATION METHOD 1) . . .	129
APPENDIX III: AN EXAMPLE OF DETERMINING THE CALIBRATION FACTOR OF A PHOTON MEASURING INSTRUMENT BY MEANS OF A MONITOR (CALIBRATION METHOD 2)	132
REFERENCES	142
BIBLIOGRAPHY	148
CONTRIBUTORS TO DRAFTING AND REVIEW	153