Contents

Preface ................................................................. iii

Executive Summary .................................................... 1

1. Introduction ......................................................... 9
   1.1 Purpose and Radiation Protection Principles .......... 9
   1.2 Audience ................................................... 10
   1.3 Basis of the Recommendations ......................... 11
   1.4 Radiation Quantities Used in this Report ........... 11
   1.5 Additions to NCRP (1993) Recommendations ....... 12
   1.6 Comparison with ICRP (2007) Recommendations .... 13
   1.7 Protection Approach for Nonhuman Biota ........... 14

2. Ethical Foundation for the System of Radiation Protection
   2.1 Moral Significance ......................................... 15
   2.2 Ethical Theories, Ethical Principles, and the Radiation
       Protection Principles ...................................... 16
       2.2.1 Ethical Theories .................................... 16
       2.2.2 Ethical Principles .................................. 16
       2.2.3 Ethics and the Radiation Protection Principles 17

3. The System of Radiation Protection ........................... 19
   3.1 Exposure Situations ......................................... 19
   3.2 Categories of Exposure .................................... 21
       3.2.1 Occupational Exposure ......................... 21
       3.2.2 Public Exposure .................................. 21
       3.2.3 Medical Exposure ................................ 22
       3.2.4 Exposure of Emergency Workers .............. 22
       3.2.5 Exposure of Nonhuman Biota ............... 23
   3.3 Radiation Protection Principles ......................... 23
       3.3.1 Justification ....................................... 23
       3.3.1.1 Addition or Removal of a Source ............ 24
       3.3.1.2 Medical Exposure of Patients ............. 25
       3.3.1.3 Exposure of Nonhuman Biota ............. 26
       3.3.2 Optimization of Protection .................... 27
       3.3.2.1 Public Exposure ................................ 29
       3.3.2.2 Medical Exposure of the Patient .......... 30
       3.3.2.3 Exposure of Emergency Workers .......... 32
       3.3.2.4 Exposure of Nonhuman Biota ............ 32
   3.3.3 Numeric Protection Criteria ......................... 32
3.3.3.1 Use of Dose Limits ................. 33
3.3.3.2 Occupational Exposure .............. 34
3.3.3.3 Public Exposure .................... 34
3.3.3.4 Medical Exposure ................... 36
3.3.3.5 Exposure of Emergency Workers ..... 36
3.3.3.6 Exposure of Nonhuman Biota ....... 36
3.4 Radiation Protection Culture ............. 37

4. Basis of the Recommendations ............... 39
  4.1 Stochastic Effects in Humans ............. 39
  4.2 Effects in Humans Other Than Cancer .... 44
  4.3 Psychosocial Effects ..................... 45
  4.4 Effects in Nonhuman Biota ............... 45

5. Numeric Protection Criteria .................. 47
  5.1 Introduction .................................. 47
  5.2 Occupational Exposure ..................... 48
    5.2.1 Protection Against Stochastic Effects ... 48
      5.2.1.1 Unique Circumstances of Exposure ... 49
      5.2.1.2 Unique Circumstances of Exposure for
               Medical Staff ......................... 50
      5.2.1.3 Embryo or Fetus ..................... 51
      5.2.1.4 Solar and Galactic Cosmic Radiation . 52
      5.2.1.5 NORM .............................. 52
      5.2.1.6 Radon .............................. 52
      5.2.1.7 Crew Members in NASA Space  
               Activities .......................... 54
    5.2.2 Protection Against Adverse Tissue Reactions ..... 55
      5.2.2.1 Skin, Including Extremities ...... 55
      5.2.2.2 Lens of the Eye .................... 56
  5.3 Public Exposure ............................ 57
    5.3.1 Protection Against Stochastic Effects ... 57
      5.3.1.1 Radioactive Material Not Previously
               Subject to Control .................... 59
      5.3.1.1.1 Radioactive Material in the 
               Environment .......................... 59
      5.3.1.2 Radioactive Material  
               Introduced Intentionally or by
               Accident ............................ 60
    5.3.2 Protection Against Adverse Tissue Reactions ..... 62
      5.3.2.1 Skin, Including Extremities ...... 62
      5.3.2.2 Lens of the Eye .................... 62
  5.4 Medical Exposure ........................... 63
    5.4.1 General .................................. 63
    5.4.2 Comforters and Caregivers .......... 63
CONTENTS / ix

5.4.3 Biomedical Research Subjects ...................... 64
5.5 Exposure of Emergency Workers ................. 66
  5.5.1 General ............................................. 66
  5.5.2 Protection Based on Preventing Acute Life-
        Threatening Effects ................................. 67
  5.5.3 Protection Based on Stochastic Effects ...... 68
5.6 Exposure of Nonhuman Biota ..................... 69

Appendix A. Definitions for the Radiation Quantities Used
  in Numeric Protection Criteria ....................... 72
 A.1 Mean Absorbed Dose in an Organ or Tissue (organ dose) 72
     A.1.1 Energy Imparted by Ionizing Radiation ....... 72
     A.1.2 Absorbed Dose at a Point ..................... 72
     A.1.3 Absorbed-Dose Rate ............................. 72
     A.1.4 Mean Absorbed Dose in an Organ or Tissue
           (human exposure) ................................. 73
 A.2 Radiation-Weighted Absorbed Dose .................. 73
 A.3 Equivalent Dose (stochastic effects) ............ 74
     A.3.1 Equivalent Dose ................................. 74
     A.3.2 Radiation Weighting Factors ................. 74
 A.4 Effective Dose (stochastic effects) ............. 76
     A.4.1 Effective Dose ................................. 76
     A.4.2 Tissue Weighting Factors ..................... 76
     A.4.3 Determination of Effective Dose in Practice 77
 A.5 Activity Concentration in Air (stochastic effects, radon) . 78

Abbreviations, Acronyms and Symbols .................... 80
Glossary .................................................... 81
References .................................................. 89
Council Committee Members ............................. 96
The NCRP .................................................. 109
NCRP Publications ........................................ 120