

# Contents

<b>Preface</b> .....	iii
<b>1. Executive Summary</b> .....	1
<b>2. Introduction</b> .....	3
<b>2.1</b> Background .....	3
<b>2.2</b> Scope and Approach .....	4
<b>3. Structure and Functions of the Brain</b> .....	6
<b>3.1</b> Brain Structure .....	7
<b>3.2</b> Barriers of the Brain .....	9
<b>3.2.1</b> The Blood-Brain Barrier .....	9
<b>3.2.2</b> The Blood-Cerebrospinal Fluid Barrier .....	10
<b>3.3</b> Brain Function .....	12
<b>4. How Radionuclides Enter the Brain</b> .....	15
<b>4.1</b> Potential Mechanisms of Transport .....	15
<b>4.2</b> Pathways of Entry of Specific Elements into the Brain .....	16
<b>4.2.1</b> Manganese .....	16
<b>4.2.2</b> Potassium Analogues .....	17
<b>4.2.3</b> Lipid-Soluble Gases and Vapors .....	18
<b>5. Illustrations of Available Biokinetic Data for Brain</b> .....	19
<b>5.1</b> Manganese .....	19
<b>5.2</b> Cesium .....	20
<b>5.3</b> Lead .....	20
<b>5.4</b> Bismuth .....	21
<b>5.5</b> Polonium .....	21
<b>5.6</b> Radium .....	21
<b>5.7</b> Uranium .....	23
<b>5.8</b> Plutonium .....	23
<b>5.9</b> Americium .....	24
<b>5.10</b> Mercury Vapor .....	25
<b>6. Case Studies of the Effect of Explicit Modeling of Brain Kinetics on Dose Estimates for Internal Emitters</b> .....	27
<b>6.1</b> Methods .....	27
<b>6.2</b> Results .....	28
<b>6.2.1</b> Polonium-210 .....	28
<b>6.2.2</b> Bismuth-207 .....	30
<b>6.2.3</b> Lead-210 and Lead-209 .....	32
<b>6.2.4</b> Plutonium-239 and Plutonium-237 .....	35
<b>6.2.5</b> Americium-241 .....	35
<b>6.2.6</b> Cesium-134 .....	37

<b>6.2.7</b>	Manganese-54, Manganese-53, and Manganese-52	39
<b>6.2.8</b>	Mercury-203 and Mercury-194 (vapor)	42
<b>6.2.9</b>	Radium-223, Radium-224, and Radium-226	42
<b>6.2.10</b>	Uranium-234 and Uranium-230	45
<b>6.3</b>	Summary	45
<b>7.</b>	<b>Potential Improvements in Dosimetric Models of the Brain for Internal Emitters</b>	<b>48</b>
<b>7.1</b>	Biokinetics Modeling of Brain Uptakes	49
<b>7.2</b>	Dosimetric Models	49
<b>7.3</b>	Medical Internal Radiation Dose Stylized Model of Substructures of the Head and Brain	50
<b>7.4</b>	Selected Tomographic Model of Substructures of the Head and Brain	52
<b>7.5</b>	Discussion	54
<b>8.</b>	<b>Summary and Conclusions</b>	<b>55</b>
<b>Appendix A. Supplemental Information on Brain Dose Assessment for</b>		
	<b>Epidemiologic Studies</b>	<b>57</b>
<b>A.1</b>	Rationale and Background	57
<b>A.2</b>	Human Populations with High Linear-Energy Transfer Radiation Exposure to Brain Tissue	58
<b>A.2.1</b>	Radionuclides that Expose Brain Tissue to Alpha Particles	58
<b>A.2.2</b>	DOE Worker Studies	58
<b>A.2.3</b>	Other Occupational Studies of Workers with Intakes of Radionuclides	59
<b>A.2.4</b>	Airline Crew Members	59
<b>A.3</b>	Strengths and Weaknesses of Worker Studies on Protection Guidance for Long Term Missions in Space	59
<b>A.4</b>	Summary	60
	<b>Abbreviations and Acronyms</b>	<b>61</b>
	<b>Glossary</b>	<b>62</b>
	<b>References</b>	<b>66</b>
	<b>Scientific Committee Members</b>	<b>76</b>
	<b>The NCRP</b>	<b>79</b>
	<b>NCRP Publications</b>	<b>88</b>