1 Introduction

This document was originally conceived as a description of the radium studies that took place at Argonne National Laboratory. It soon became evident, however, that to document the widespread use of radium, a brief review of the application of radium in medicine and in the U.S. dial painting industry is required. Further, because the Argonne studies were not the only such efforts, brief overviews of the other radium programs are included. Even so, much material has been omitted. The extensive references included will allow the interested reader to find additional information.

The effects of internally deposited radium in humans have been studied in this country for more than 75 years. Some 2,400 subjects have had their body contents of radium measured, and a majority of them have been followed for most of their adult lives, to understand and quantify the effects of radium. Many more individuals acquired radium internally but were never measured. Some of this group have been located and followed until death; in these cases the cause of death is known without a body content measurement.

As a consequence of the efforts made to locate, measure, and follow exposed individuals, a great deal of information about the effects of radium is available. Nevertheless, great gaps remain in our knowledge of radium toxicity. For example, when an adult woman, over a period of several months or years, ingests 5,000 μCi of ^{226}Ra or receives 1,000 μCi of ^{226}Ra by intravenous injection,* she has a relatively high probability (30-50%) of developing a bone sarcoma or head carcinoma induced by internal radium, 5-50+ years later. If an adult male receives the same quantity of radium, he too is at risk, but the probability that he will develop a malignancy appears to be much lower. Is this difference real?

The probability of the induction of one type of radium-induced malignancy, the bone sarcoma, in an adult female appears to be very low when the quantity of ^{226}Ra absorbed into the blood is less than 100 μCi. The probability then rises rapidly with increasing radium intake. This rise is not linear, but it is better characterized by the square or cube of the radium intake. Are the data that lead to this conclusion valid?

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* This document is a review of work covering much of this century. Most of the published information reports activities in curies. The author has chosen to retain this convention instead of converting activities to becquerels, the International System unit. (The becquerel [Bq] is equal to 27 pCi.) A different approach has been adopted for dose. The traditional unit, the rad, is equivalent to 0.01 Gy (gray). Therefore, all dose values are stated in cGy and are numerically equal to previously published dose values in rads.