

1993-94 SESSION
COMMITTEE HEARING
RECORDS

Committee Name:

Joint Committee For
Review of Administrative
Rules (JCR-AR)

Sample:

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- 05hrAC-EdR_RCP_pt01b
- 05hrAC-EdR_RCP_pt02

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➤ **

➤ Clearinghouse Rules ... CRule

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➤ **

1 Quite often we characterize people with
2 internally-deposited radioactivity in terms of the
3 dose that's delivered to various organs in the body.
4 There's nothing wrong with that approach. You must
5 characterize very specifically what organ that you're
6 calculating the dose to.

7 One of the things we found when we studied these
8 radium-containing individuals is they live so long,
9 so that when we first started studying them, we
10 determined how much radium was in there body, and we
11 would calculate the dose to the surfaces of bone or
12 to the bone itself.

13 But we were a little disturbed about publishing
14 that data because most of these people were still
15 alive, and each year -- as each year went by, the
16 total dose in their body increased because the radium
17 was still in there, and we felt this was a little
18 unsatisfactory.

19 So we devised another measure of the radium
20 insult, and that was the total quantity that entered
21 their blood. Once they were through being exposed to
22 radium, that quantity was fixed, no matter how long
23 they lived. It was a characteristic that was
24 constant and stayed with them.

25 So we often expressed the insult to an

1 individual in terms of the quantity of radium that
2 entered the blood. Now, that we call systemic
3 intake. It's not the intake to the mouth, but it's
4 the intake that is absorbed across the gut and enters
5 the blood. It is equivalent to the intake that you
6 would get from an intravenous injection of radium
7 into a vein.

8 In that paper I use that unit and postulated
9 that there apparently was a threshold below which
10 none of these people developed malignancies.

11 I should say that I haven't defined the
12 malignancies that are found in radium cases. There
13 are two. The most obvious one is a sarcoma that
14 arises in bone, often called an osteosarcoma,
15 sometimes called bone cancer. But primarily, it's a
16 osteosarcoma that arises in bone, and that's the
17 standard trademark of high levels of radium.

18 A second malignancy occurs at a much later time,
19 and that is a carcinoma. It's a carcinoma that
20 arises in the mastoid air cells or the paranasal
21 sinuses. These are cavities in bone in which we
22 think the radon gas that's released from radium
23 migrates to and gets trapped and can't get out, and
24 so it stays there and give rise to a whole series of
25 radioactive daughter products, all of which radiate

1 the cells around these air cavities.

2 So we called these two different types of
3 carcinomas head cancers in short. And those head
4 cancers are -- have been noticed to be only half as
5 frequent as the bone sarcoma, but these are the two
6 malignancies that we know radium can induce in
7 humans.

8 Now, we found that when we plotted the number of
9 malignancies versus the systemic intake, the radium
10 that entered the blood, there were none below a
11 certain level. Then above that level there was a
12 rapid increase in the induction of malignancies.

13 And so in this paper I postulated that there was
14 a threshold, and I indicated that it was of the order
15 of 75 to 80 total microcuries of radium that entered
16 the blood. And if one is interested in radium that
17 enters the mouth, about one-fifth of what enters the
18 mouth eventually reaches the blood. So if it's about
19 a threshold of 80 microcuries of radium systemic,
20 that means the threshold is about 400 microcuries of
21 oral ingestion.

22 This paper was really the first time, shall I
23 say, we had the courage to say that. The reason I
24 use the word courage is because we were all brought
25 up in a doctrine that all radiation is harmful. No

1 matter at what level, it does damage. And these
2 radium cases make mockery of that statement. It is
3 one of the relatively few cases that is so
4 well-documented that suggests that that hypothesis,
5 that all radiation is harmful, is not correct.

6 It turns out there apparently is a threshold for
7 radium, and this is the first time that I came out in
8 print using the word threshold, although it is
9 suggested in my book that was previously discussed.

10 In essence that's the point of this paper, there
11 is a threshold, and it can be measured in terms of
12 systemic intake into the blood or oral intake to the
13 mouth.

14 BY MR. FUHRMAN:

15 Q All right. Now, I'd like to draw your attention to
16 Exhibit 9 for identification and ask you to state
17 what that document is.

18 A This is a reprint of the paper I presented by
19 invitation in France this past year. It's entitled
20 Bone Sarcoma in Humans Induced by Radium: A
21 Threshold Response.

22 Q Would you briefly summarize that for us, please?

23 A This paper is very similar to the previous one,
24 except that in this particular case, I use the
25 measure of dose delivered to bone, a more

1 conventional unit, and plotted the data and indicated
2 that there was a threshold when we use dose to bone
3 and that that threshold took place at about 1,000
4 rads or 10 gray. Both rads and gray are measures of
5 dose delivered to a tissue. And I indicated that
6 there was a very sharp threshold at around 1,000 rads
7 or 10 gray and that no one below that level of dose
8 ever experienced a radium-induced malignancy.

9 Q Now, I would like to go back to Exhibit 5 just by way
10 of reference. That is the statement that you
11 prepared in 1991 for the DNR and the Radiation
12 Protection Council. And my question to you is have
13 you at my request updated Exhibit 5 to reflect the
14 studies of radium since 1991?

15 A Yes, I have.

16 Q And I draw your attention to Exhibit 10 and ask you
17 whether that is your updated document?

18 A Yes, it is.

19 Q And it basically recapitulates the testimony that you
20 have just given in regard to the Exhibits 8 and 9?

21 A It recapitulates that material, yes.

22 Q All right. One term that we've used extensively here
23 but which hasn't really been defined yet is the word
24 radium. Would you define for the record what radium
25 actually is?

1 A Radium is an element. For those of you who remember
2 chemistry, it appears in the Periodic Table of the
3 Elements. It is a radioactive material, and it comes
4 in several different isotopes.

5 It is only on the earth because it's -- it has a
6 relatively long half-life -- if we talk about the
7 most familiar isotope, which is radium 226, it has a
8 half-life of 1620 years. All the other radium
9 isotopes -- and there are a lot of them -- have
10 shorter half-lives. But 1620 years is not long
11 enough to make radium available on earth because it
12 would all have been long gone.

13 Radium is derived from a parent element, uranium
14 238. Uranium 238 is a long-lived radioactive
15 material, which when it decays gives rise to a whole
16 family of radioactive isotopes, one right after the
17 other with various half-lives, until it reaches
18 stable lead 206. There are a lot of daughters of
19 uranium 238.

20 Uranium 238 has a half-life of 4.5 billion
21 years, which is approximately the age of the earth,
22 as is now considered, and that's why it's still here.
23 Since the earth was formed, only half has decayed,
24 and it continually creates more radium 226, and that
25 is the subject that has drawn our attention right

1 now.

2 But I should also add that radium 226, as a
3 consequence of being a parent of uranium -- a
4 daughter of uranium 238, is not only present on the
5 world today, but it's present uniformly, and this
6 often comes as a surprise.

7 Radium and uranium are fairly uniformly mixed
8 throughout the surface of our globe, and I often
9 illustrate this by saying that when you work in your
10 garden and dig a pot a soil, that soil contains a lot
11 of radium, much more than people realize.

12 One way I can illustrate the abundance, not only
13 radium and uranium, but all the other what we call
14 natural radioactive materials, is to try to tell you
15 how many -- how much there is, and for that I'll use
16 a unit of volume, the liter. We talk about a maximum
17 contaminant level for radium in a liter of drinking
18 water, and so I'll use the same -- same idea.

19 In a liter of soil, there are approximately
20 1,200 picocuries of uranium 238. There are also
21 1,200 picocuries of radium 226. There is also about
22 2,000 picocuries of thorium 232 and approximately
23 2,000 picocuries of radium 228, which is a daughter
24 of thorium 232.

25 There are other isotopes present. There is an

1 isotope known as rubidium, rubidium 87, and its
2 concentration in the earth is higher than all those
3 I've mentioned so far, and for the moment it escapes
4 me how high it is. It's a couple thousand picocuries
5 per liter.

6 But the most prevalent natural radioactive
7 material is potassium, potassium 40. And in my liter
8 of soil, there are 24,000 picocuries of potassium 40.

9 We live on a very radioactive planet, and I find
10 that very few people are aware of just how much
11 radioactivity exists on our planet. As a consequence,
12 all of our food contains radium, and in many cases
13 more radium enters the human body from food than does
14 from drinking water.

15 Q You have used the term daughter a number of times.
16 Would you state what the definition is for the
17 purpose of your testimony?

18 A Every time a radioactive atom decays, undergoes this
19 radioactive decay process, it changes its name. It
20 becomes a different element.

21 For example, if we start with radium 226, when
22 it decays it becomes an atom of radon. Radon is a
23 gas, a noble gas, and it's radioactive, and it decays
24 with a certain half-life, which in this particular
25 case is 3.8 days, and it becomes an atom of polonium,

1 which in turn decays and becomes an atom of lead.

2 These are long chains and go back and forth, and
3 this is what we mean by a daughter product. You
4 start with a predecessor, and as time goes by, each
5 of the daughters is formed in turn. In the process
6 some sort of radiation is given off. What we mean by
7 the word daughter is something that's been born of a
8 previous radioactive decay.

9 Q All right. You've already indicated to some extent
10 that radium is found throughout the globe. Can you
11 comment on that briefly as to what the extent of its
12 distribution is?

13 A Well, I would -- I would make a generalization and
14 say that everyone born on earth, living on earth,
15 contains radium in their body. The level is about 30
16 or 40 picocuries in an adult. And without exception,
17 everyone must have this because all our food contains
18 radium.

19 How much food -- how much radium is in the food
20 or how much radium or other isotopes are present,
21 again, apparently is a -- is not a well-kept secret,
22 but not very many people seem to be aware of it.

23 We know about radium in drinking water. We talk
24 about a current level of 5 picocuries per liter of
25 drinking water. But if we ask the question, How much

1 radioactivity is there in drinking water, the
2 answer's probably on average about 20 picocuries for
3 every liter of other isotopes. Total of about 20
4 picocuries in water.

5 I was fascinated to find that beer has 390
6 picocuries per liter. Milk has 1,400 picocuries per
7 liter of total radioactivity in it. If you look at
8 it that way, you'll see that water is a rather pure
9 material.

10 Nuts are good sources of radioactivity, and
11 everyone knows who needs potassium in their diet --
12 we all do -- bananas are an excellent source of
13 potassium. Potassium, as I've indicated, is
14 radioactive, and so when we eat bananas on our cereal
15 or when we tak a pill supplied by our physician to
16 make up for loss of potassium, if we're on a
17 diuretic, that pill is radioactive, quite
18 radioactive. But for reasons that escape me, it is
19 not well-publicized that there are all these various
20 kinds of radioactivity in our food, in our liquids,
21 in our medications.

22 Q Would you state what the health significance of
23 radium within the human body and within the foods
24 eaten by humans is?

25 A If we list ourselves -- confine ourselves to radium

1 as normally present in food or normally present in
2 drinking water, there is in my opinion absolutely no
3 hazard to humans from that level of radium which ends
4 up in the body. No hazard. Not immeasurably small,
5 but just no hazard.

6 Mankind has existed on this earth since it
7 evolved, and we perhaps have learned to live with
8 these low levels of naturally-occurring radioactive
9 materials in our body.

10 Q What is -- I think that you have touched on this
11 before and so this may be a little redundant, but
12 would you tell us for the record what is the
13 relationship between radium 226, radium 228 and
14 uranium 238?

15 A I've indicated previously that uranium 238, an
16 isotope with a half-life of 4 1/2 billion years,
17 gives rise eventually to an isotope known as 226
18 radium, a radioactive material with a half-life of
19 1620 years. This is of primary concern to us today
20 because of the level in our drinking water.

21 Radium 228 has a completely different source.
22 Radium 228 is a daughter of a different isotope,
23 thorium 232. Thorium 232 has a half-life, I believe,
24 of about 13 billion years, which is considerably
25 longer than the age of the earth. It gives rise to a

1 long chain of radioactive daughters, one of which is
2 radium 228.

3 Radium 228 has a half-life of 5 3/4 years. It's
4 a different radium in the sense that it does not give
5 the characteristic alpha particle that the other
6 radium isotopes emit when they decay. Radium 228
7 decays by the emission of the beta particle, which is
8 what we find in potassium 40.

9 Radium 224 is also a member of the thorium 232
10 decay chain. It's a radium isotope with a half-life
11 of 3.6 days and emits in an alpha particle. Since it
12 has a very short half-life, it must be obtained from
13 its predecessor, its parent, very quickly before it
14 is used before it's available to give to an
15 individual.

16 Radium 224 has achieved a minor level of fame
17 because in Germany it has been used as a medication
18 to alleviate the pain from a disease known in Europe
19 as ankylosing spondylitis, which we translate to be
20 arthritis of the spine.

21 Interestingly enough, this cure works. People
22 who have received -- who receive weekly injections of
23 radium 224 find that they lose the pain from this
24 type of arthritis. Unfortunately, when it was first
25 used, high levels were used, and those people

1 ultimately succumbed to the famous bone sarcomas that
2 are induced by radium 226. They are also induced by
3 very high levels of this isotope radium 224.

4 It was then used as a medication in Germany at
5 much lower levels, and the last publication I recall
6 seeing, which might be in 1971, indicated it was
7 still in use in Germany as a medication to relieve
8 those with ankylosing spondylitis.

9 Q Another term I would like to have you focus on is
10 known as radionuclides. That is the term of the EPA
11 rule-making proceeding that we referred to earlier.
12 And I surmise from what you just said that all of the
13 daughter products of radium and uranium probably are
14 radionuclides; is that correct?

15 A Well, technically, radionuclides refer to any
16 radioactive element or isotope of a radioact -- of an
17 element that is capable of decaying, of giving off
18 radiation and turning into a different element.

19 All of the daughters in a chain are
20 radionuclides until you get to the last one, and that
21 is a stable material. Then the chain ends, and
22 usually it ends for the uranium 238, thorium 232, as
23 an isotope of lead, which is then stable.

24 Basically, you can think that we have two kinds
25 of isotopes, stable isotopes, which mean they never

1 decay, and radioactive or radionuclides, which have
2 the property that they will decay, give off energy
3 and change into a different element eventually.

4 Q And that is, therefore, its definition?

5 A That's the definition of a radionuclide.

6 Q Are you familiar with the nature of the City of
7 Waukesha municipal water?

8 A Yes, I am.

9 Q Do you understand that the municipal water supply of
10 the City of Waukesha's water utility contains more
11 than 5 picocuries per liter of radium 226 and radium
12 228 combined?

13 A I have been told that is the case, yes.

14 Q Assuming that is the case.

15 Do you understand that the water supply of the
16 City of Waukesha and its water utility contains less
17 than 20 picocuries per liter of radium 226 and radium
18 228.

19 A Yes. I have seen the figures and they are
20 considerably less than the value of 20.

21 Q Perhaps we'll be a little redundant here again, but
22 the -- you, I believe, have previously indicated the
23 extent of a health hazard by radium in the body, and
24 is this a correct statement, that there are only two
25 types of cancer that are generated by radium in the

1 human body?

2 A We have only been able to definitely show that there
3 are only two malignancies that can be attributed to
4 radium. It is conceivable that there might be
5 others, but our population has been too small to
6 identify another type of cancer.

7 Cancers that have been suspected are lung
8 cancer, and it has been suspected that people who
9 worked as radium chemists in the very early days who
10 wore no protective devices and stood over boiling
11 cauldrons in which radium was being evaporated might
12 conceivably have inhaled a lot of radium, entering
13 the body by that pathway. However, we have not been
14 able to show any increase in lung cancers in these
15 individuals.

16 There's been a suspected increase in --
17 suspicious, I should say -- suspicious increase in
18 breast cancers in women who painted watch dials, and
19 at one time we thought that this was something
20 induced by radium.

21 We think now that it's due to the nature of the
22 work in the sense that as these women sat at a low
23 desk and painted their dials, they had various
24 habits, and some people seemed to keep their pot of
25 paint out far away from them, dipped into it, but

1 others would bring a pot of paint right close to
2 their chest.

3 And so we're somewhat suspicious that there
4 might be an increase in breast cancer, not due to
5 radium in the body, but due to the radiation given
6 off by this pot of paint in close proximity to the
7 chest.

8 Again, data is not good enough to prove it, and
9 some dial painting plants had instead of an excess of
10 breast cancer, an actual shortage of breast cancer in
11 their population of people who worked there. So it's
12 one of those up-in-the-air things. The only ones we
13 know for sure are bone cancer and those carcinomas
14 arising in air cells in the head.

15 Q Are you aware of the studies that came to more dismal
16 conclusions than yours in that regard?

17 A Well, there are several such studies, and,
18 incidentally, they are included in this Item No. 10,
19 in this paper I wrote for you not too long ago -- or
20 updated, I should say. It was prepared in 1991 and
21 I updated it recently.

22 Q You're referring now to Exhibit 10?

23 A Exhibit 10.

24 Q All right.

25 A In this exhibit I go back in history and I review all

1 of the studies that purported to show affects from
2 radium. There were a couple of studies in the State
3 of Iowa, and they found elevated levels of bladder,
4 breast cancer in women, but none of the malignancies
5 that we're aware of.

6 There was a study in Florida that examined areas
7 where there's high phos -- a lot of phosphate mining.
8 The phosphate that's used in fertilizer is quite
9 radioactive, and they assumed that the people who
10 lived in these regions might be drinking water with
11 radium in it, but they didn't measure. And they
12 found an elevation of leukemia in Florida.

13 These studies were reviewed by the National
14 Research Council of the National Academy of Science
15 in a document that we call Bier 4.

16 Q Would you spell that?

17 A Yeah. I'd forgotten. It's B-i-e-r or B-e-i-r. You
18 might have that.

19 Q I would suggest --

20 A Oh, I probably have it right here, too.

21 Q -- B-i-e-r.

22 A B-i-e-r, Bier 4. Bier 4 is quite famous because it
23 really looks at the radiations -- the radionuclides
24 in the radium family to see what has relevance.
25 Bier 4 is entitled Health Risks of Radon and Other

1 Internally-Deposited Alpha Emitters.

2 Both of the studies I referred to, the one in
3 Florida and the one in Iowa, were revealed in some
4 detail in this document from the National Academy of
5 Sciences, and they came to the conclusion that they
6 were essentially without merit. They found -- each
7 one found different end points, and these end points
8 didn't agree with any other study of radium, and so
9 they felt that there wasn't enough to go on.

10 Subsequent, there's been a very interesting pair
11 of studies coming out of Canada, senior author being
12 a physician by the name of Finkelstein. Finkelstein
13 had a somewhat interesting findings in the sense that
14 he is considering -- he considered two populations.

15 The first population was those who developed a
16 bone cancer below the age of 26, and he went through
17 the records for the Province of Ottawa, and over a
18 certain time period found all the cases of bone
19 cancer -- note that it's not osteosarcoma; it's bone
20 cancer -- that occurred. And then he tried to
21 determine what the radium level of the water was
22 where this person was born.

23 He went way back in history and decided whether
24 there was radium in the home-place water and he
25 called anybody who had more than about two-tenths of

1 a picocurie per liter as being exposed, high-level
2 radium, and he came to the conclusion that there
3 might be an increase in bone cancer in those people
4 born where he found elevated radium levels.

5 He subsequently published with a co-author a
6 second paper in which he limited his cases to those
7 who developed sarcomas of bone and again looked at
8 the birth-place water and again used about two-tenths
9 of a picocurie as high-level water and everything
10 below it as low-level water, and he found again, he
11 thought, more sarcomas than expected in the so-called
12 high-level water, but he found that that number did
13 not increase as the level of radium in the water went
14 up.

15 Now, one of the tenets of a dose-response
16 relationship is, one, the material, the radionuclide
17 must cause the effect and the frequency must go up
18 with increasing dose. He found that the frequency
19 went down with increasing dose.

20 Now, if we take his findings as gospel truth,
21 which I do not, it says that it would be very
22 dangerous to lower the level of radium in our water
23 down to two-tenths of a picocurie because then you
24 get bone cancer, but if you get it up to about a
25 picocurie, then you're all right. And I can't accept

1 that. And so I find that his statistics are somewhat
2 misleading.

3 But it's important to mention that because I
4 suspect that those findings of his will take on
5 greater and greater importance as time goes by, that
6 more and more people will grab on to those as a
7 reason for keeping the radium level very, very low in
8 drinking water.

9 Q Has the EPA ever published information relating to
10 other sources of radium besides drinking water?

11 A Well, EPA recognizes that all our foods contain
12 radium, but, of course, that's not something that
13 they are in a position to control.

14 Q Are you familiar with a publication of the EPA in 51
15 Federal Register 34838 that came out in 1986?

16 A I remember particularly that document as stating that
17 the reason they chose 5 picocuries per liter as a
18 maximum contaminant level for radium 226 and 228 in
19 drinking water was that that was for all practical
20 purposes as low as they could measure reproducibly,
21 and, secondly, because they thought radium was the
22 most dangerous element known to man at the time. I
23 find this somewhat surprising, but these seem to be
24 the high points in my mind of that particular
25 document.

1 Q And the document made some reference to radon as
2 well?

3 A Yes. But radon has been a substance we haven't
4 really paid much attention to in water in this area
5 of the United States. In other areas it's very big.

6 One of the problems, of course -- one of the
7 unknowns about radium unknown to most people is the
8 fact that radon has the consequence of being the
9 first daughter of radium, which I have pointed out
10 was spread uniformly over the surface of the earth
11 throughout all the rocks and soil. Radon is
12 continually coming out of the ground and continually
13 exists in the air outside that we breathe and the air
14 that we breathe inside.

15 And radon and its daughter products are admitted
16 by the EPA to create the greatest hazard to man from
17 natural radioactive materials because they give a
18 dose to the entire body and even to bone that is far
19 greater than any other dose achievable from natural
20 radioactive material, far more dose to bone from the
21 gas radon that we breathe than we could ever acquire
22 from radium in drinking water.

23 Q Have you reviewed figures as to the radium level
24 found to be in the drinking supply of Waukesha and
25 what conclusions have you come to?

1 A I concluded that the level in the Waukesha water,
2 which was higher than 5, considerably lower than the
3 20 standard, posed absolutely no hazard to those
4 drinking it.

5 Q Do you have an explanation for the adoption by the
6 EPA of the 5 picocurie per liter national drinking
7 water standard promulgated in 1986?

8 A If I remember that -- I first saw that in 1975, did I
9 not, that the interim level was 5 picocuries per
10 liter. In 1986 they indicated -- I think I mentioned
11 earlier -- they thought it was a very, very dangerous
12 material, didn't have any quantitative information,
13 except that they thought the risk was 1 in 10,000, I
14 believe, if one drank that water for a lifetime.

15 Q Is there any professional research results that would
16 support that assumption?

17 A No.

18 Q What is the scientific or empirical validity of the
19 current standard of the MCL; that is, the maximum
20 contaminant level of 5 picocuries per liter for
21 drinking water for radium 226 and radium 228
22 combined?

23 A In my opinion there is no reason to suggest a level
24 as low as 5 picocuries per liter as the maximum
25 contaminant level, and frankly, I'm of the opinion

1 that the EPA has recognized this in their 1991
2 publication where they have suggested that the levels
3 of 20 picocuries per liter for each of the two radium
4 isotopes.

5 Q So the current maximum contaminant level of 5
6 picocuries per liter of radium 226 and radium 228
7 combined is not a valid measure of health threat
8 through human consumption?

9 A Put it a different way. I see no reason for making
10 it at 5 picocuries per liter because there is no
11 information whatsoever that there's anything wrong
12 with 10 picocuries per liter or, for that matter, 20
13 picocuries per liter. It's unnecessarily restricted.

14 MR. FUHRMAN: That's all at this time. Do
15 you have any?

16 MS. HIRSCH: Just a few questions.

17 EXAMINATION

18 BY MS. HIRSCH:

19 Q Dr. Rowland, I'm not a scientist. I'm a lawyer. I'm
20 going to attempt to ask you a few questions. I hope
21 you'll forgive me if I don't ask them as precisely or
22 with the correct language as I'm sure you would ask
23 them or one of your colleagues would ask them.

24 I'd like to ask you a few questions about the
25 radium dial painters. Were all of the radium dial

1 painters who ingested the solution by licking the
2 brushes prior to 1925 identified?

3 A Not all, no.

4 Q Approximately what percent of them to the best of
5 your knowledge were actually identified?

6 A Well, we -- I think you'll find in my book a table
7 that shows the fraction from four different dial
8 painting areas, and I can't remember without looking
9 what those fractions were, but I think that in --
10 they went somewhere in the 50 percent, plus or minus
11 20 or 30 percent, something in that broad range. We
12 made no claim whatsoever that we were able to find
13 all of the dial workers.

14 Q And of those that were identified, what percentage of
15 those were examined?

16 A When we call them identified, I'm calling them all
17 examined. I should -- I guess I should back up and
18 clarify for you.

19 We have a population of 2,400 examined radium
20 cases, and by examined we mean that individual came
21 to the laboratory and the radium content was measured
22 of the body. We have in total more than 6,000
23 identified people who we suspect have radium in their
24 body, and you see 2400 is a small fraction of that
25 6,000.

1 On the other hand, we have remarkably complete
2 records in the form of death certificates of the
3 deceased members of that 6,000 population. We have a
4 file on every one of the people we have identified as
5 being potentially exposed to radium, and when they
6 died, through the courtesy of the Social Security
7 Administration, we were able to get a death
8 certificate for most of them.

9 Q But every person who died from cancer was not looked
10 at for the radium content in their bodies, were they?

11 A No, not everyone that died from cancer was looked at.

12 Q Do you know what percentage of those were looked at?

13 A If I remember, we saw 64 bone sarcomas in our
14 measured population, and that means we studied those
15 people very carefully, autopsies and what have you.
16 Again, the book will tell you. I think the number
17 was 87 people we identified total including those 64,
18 who died with bone cancer. So the difference between
19 the 64 and the 87 were the unmeasured -- or the
20 unexamined.

21 Q Okay. I have a question about the impact of high
22 levels of radium being ingested on one's bones, and I
23 think this is related to what you've been explaining
24 all along, but I have some questions I think I need
25 to ask in my terms.

1 When you looked at the bones of the radium dial
2 painters, would you characterize them as normal or
3 abnormal?

4 A It depended upon the level of radium in the bones.
5 Very good question.

6 We found that people who had high levels of
7 radium in their body could be diagnosed as having
8 radium, first, by a gross skeletal X-ray. We found
9 that for high-level cases, one could identify a
10 radium case by a characteristic pattern on the X-ray,
11 and, in fact, a number of our radium cases that we
12 didn't know about, those who had got their radium
13 from physicians, were identified for us by hospitals
14 which said, This radiograph looks very much like a
15 radium case, and they would send that person to us,
16 and sure enough, we would find high levels of radium.
17 This only works for very high levels of radium. But
18 it does work, we can tell.

19 At lower levels I personally was involved in a
20 study of bone from deceased radium cases in examining
21 the blood-carrying canals that go out through the
22 compact bone, and my studies noted that these
23 bone-carrying vessels in the -- blood-carrying
24 vessels in the midst of bone would often be plugged
25 in radium cases, and the fraction of these blood

1 vessels that were blood was also crudely related to
2 the body count.

3 We also extended the studies down to so-called
4 normal individuals and studies looked at the extent
5 of plugging of normal bone, and we found to our
6 surprise that all normal bone showed a small level of
7 plugging. We were attempting to use the plugging as
8 a measure of body content of radium, but we found
9 that the very lowest-level cases merged into the
10 so-called unexposed cases, which is probably what we
11 would expect.

12 So we do know that all of us have a certain
13 level of plugging of vessels -- in the blood vessels
14 in bone. Apparently, it's a normal sequence in
15 aging.

16 Q But it appears that when you're exposed to high
17 levels of radium, your bones have a different
18 structure?

19 A Yes, they most certainly do.

20 Q And that's a fairly extensive pathology; would that
21 be accurate?

22 A Yes. But the key word there, unfortunately, is high
23 levels of radium. It takes a very high level of
24 radium.

25 And, in fact, one of the things we learned is

1 that the symptom that is visible at the lowest radium
2 dose is the malignancy, the bone cancer or the
3 carcinoma. To get -- one of the things that happened
4 to the early dial painters was the spontaneous
5 fractures of bone. They would walk and break a leg,
6 just walking. But that takes levels ten times higher
7 than required to cause a malignancy. Those visible
8 changes in bone take very high doses.

9 Q Would this high level of exposure that changes the
10 characteristic of bones also affect metabolism?

11 A I don't know. If by metabolism you mean metabolism
12 of food within the human body, I couldn't tell you
13 that. I know of -- I know of no studies in that
14 area.

15 Q Is part of your conclusion or opinion based upon an
16 examination of how exposure to radiation affects
17 metabolism?

18 A Well, again, I shy away from the word metabolism.
19 What does metabolism mean? I always think of how we
20 gather energy from our food stuff. Perhaps I can
21 express it better.

22 One of the things we found most interesting was
23 the fact that radium can cause a shortening of life
24 span. We examined, again, the dial painters in this
25 respect, and we found that there -- it used to be

1 thought, I should say parenthetically, that all
2 radiation would manifest itself one way or another
3 and if it didn't have any obvious way, it probably
4 shortened life span.

5 So we looked at life span and we found that if
6 we take our approximately 20-year-old ladies who
7 started painting dials, and they showed a small, but
8 statistically significant, shortening of life span.

9 If, however, we then went and looked at this
10 population, which could be a thousand, 1500 women,
11 and selected out just those people who died with the
12 malignancies caused by radium, we didn't select out
13 the high-level cases, just the people who had
14 radium -- who had malignancies, which is at any
15 level -- at any high level, about one-third of the
16 women succumbed to a malignancy over the threshold
17 level, about a third.

18 If we selected out those cases that developed
19 malignancies and then looked at the rest of the
20 cases, regardless of how much radium they had in
21 them, there was no life-shortening. This came as a
22 really shocking surprise because not only did it say
23 that there was no life-shortening with the low-dose
24 cases, it said at the high doses where they didn't
25 get a malignancy, their life wasn't shortened either.

1 So one of the most amazing things that came out
2 of this study -- and I think it's emphasized in the
3 book -- is that there was no life-shortening if you
4 didn't get a malignancy, and which also says, since
5 malignancies all occurred at very high doses, if you
6 looked at doses higher -- lower than those -- than
7 that threshold, there was no life-shortening
8 whatsoever.

9 Q If I understand your previous testimony correctly,
10 the people who were affected, who got malignancies
11 and who got very sick, were the individuals who
12 actually ingested the radium prior to 1925?

13 A As dial painters.

14 Q As dial painters.

15 A Yes.

16 Q I'm only talking about dial painters.

17 A Fine.

18 Q I should have --

19 A That's fine.

20 Q Okay. Those dial painters who were told in 1925
21 approximately not to lick the brushes who were also
22 studied, those dial painters who did not ingest
23 radium after 1925, I believe you said didn't even get
24 malignancies?

25 A Did not get malignancies after 1925, if they started

1 work after '25.

2 Q At least those dial painters who you were able to --

3 A Right.

4 Q -- examine and follow?

5 A And those that we didn't -- weren't able to examine
6 that died with a bone cancer all started before 25 as
7 well.

8 Q But the group that started after 1925 didn't actually
9 ingest any radium?

10 A Oh, yes, they did, because, you see, when they came
11 to the lab, they were measured. They were measured
12 with a device called a whole body counter, which we
13 sat someone in a shielded enclosure, trying to keep
14 out the cosmic rays, the radiations from soil and
15 things of that nature. We used clean World War II
16 steel before fallout for the room. We cleansed the
17 radon out of the air before it was put into the room
18 where they sat, and we sat them in a room for 40
19 minutes and counted the gamma rays that emitted from
20 the body. Almost everybody who worked in the dial
21 painting plant, almost, has radium in their body,
22 detected.

23 Now, all of us, I said earlier, have radium in
24 our body. That's not detectable by gamma rays. We
25 have to collect the radon in the breath and then

1 measure that. But most, but not all, most of the
2 dial workers after 1925 had detectable radium in
3 their body. There's no doubt about that.

4 Q Okay. I understand that and I understand that you or
5 I or Mr. Fuhrman would probably have detectable
6 radium in our bodies.

7 A Not by gamma rays, but by one way or another we can
8 detect it.

9 Q My question is if we know this group of people who
10 started after 1925 didn't actually lick their
11 brushes, then what you're measuring in their body is
12 radium that got in another way?

13 A Yes.

14 Q So what you have is a group that drank a lot of
15 radium and a group that didn't drink any radium; is
16 that accurate?

17 A Well, you got to be a little bit careful because
18 where you use the word drink, I would use the word
19 ate, but it's the same thing.

20 Q Okay.

21 A But the radium dial plants were contaminated
22 unbelievably with radium. Go back to 1924, we as a
23 country new very little about radiation. There is a
24 profession called health physics. It didn't exist
25 until 1950. There was no one in those plants who

1 made a survey of the radioactivity that was on the
2 table, on the floor, on the wall, on the clothing of
3 these people.

4 One of the fascinating chapters in this history
5 is that this paint contained radium, but it also
6 contained something that made it light, made it
7 visible, a fluorescent material. It turned out that
8 when these women went home, if they stood in the
9 dark, their clothing glowed because they had so much
10 paint on their clothing. They had it everywhere.

11 In the era in which I was actively working in
12 the lab, women would come in to us and they'd bring
13 us lists of their cohorts, lists in the form of
14 address books or autograph books, and those were so
15 hot with radium that we had to put them in plastic
16 bags because otherwise we'd be breaking into our
17 health physics regulations of the laboratories.

18 So these people didn't eat a lot of radium, but
19 they lived in radium. And it's a tragic thing to
20 realize that -- the conditions under which they
21 worked. And, fortunately, there have been some
22 studies made by the Department of Labor after 1925.
23 They went into these plants and measured the radon in
24 the air and the radium on the floor, in the cracks,
25 on the desks, and what have you, and the numbers are

1 astoundingly large. They worked in a very
2 contaminated area.

3 So that when I say we measured the radium
4 content of the dial painters after '25 and found
5 radium -- this is very significant -- it doesn't mean
6 they're individuals drawn off the street. We have
7 never found radium detectable by a whole body counter
8 on a person drawn off the street. Never.

9 Q Okay. My question has to do with eating the radium.

10 A Um-hum.

11 Q We have a group of people that before 1925 ate large
12 amounts of radium. And then you looked at a group of
13 people that after 1925, although you say were exposed
14 to radium in the work environment, did not actually
15 eat radium if they followed the rules.

16 A Right.

17 Q In those two groups you saw a big difference in the
18 amount of illness?

19 A We saw a big difference in the amount of
20 induced-malignancies, yes, that's true.

21 Q Okay. How then can we say anything about the amount
22 of malignancies or the amount of illness that might
23 occur in a group of people who are eating radium but
24 are eating smaller amounts over a long period of
25 time?

1 A Well, you and I are having trouble with a meeting of
2 the minds. I think we're going buck by each other.

3 We have measured the radium body content --
4 let's take the radium dial painters. We had a -- my
5 recent studies looked at about 1700 female dial
6 painters, and if we line them up in terms of how much
7 radium is in their body, highest level over here and
8 the lowest ones down here, the top approximately 200
9 got malignancies. The next 1300, all with measured
10 body burdens, showed nothing. And why? Because
11 their body burdens before 1925 tended to be up here;
12 after 1925 tended to be down here, a bottom factor
13 ten to a hundred less, but they all had measurable
14 rating.

15 Q And that's why you're comfortable with your threshold
16 opinion?

17 A That's exactly right, because we have so many people
18 below the threshold who are measurable.

19 Q All I'm asking is is it the situation where people
20 are eating radium, but they're eating smaller amounts
21 in their drinking water over a much longer period of
22 time, but they're eating it every day, not just in
23 the work place, not just for a few years, but every
24 day over a lifetime for a much longer period of time,
25 isn't that a very different situation?

1 A Well, it is different, quite right. Good point. But
2 we have seen no explosion of radium-induced
3 malignancies for those of us who eat peanut butter
4 sandwiches every day.

5 These are people who eat radium -- we all -- we
6 can't help but eat radium, and we can probably stay
7 away from radium by choosing our diet very, very
8 carefully, but I think you'll find that we all are
9 eating radium and we always have as far back in
10 history as we want to go. This is not something new,
11 this eating of radium. It's gone on forever.

12 And yes, there are naturally-occurring bone
13 cycles, and what you're going to have to do is say,
14 All natural-occurring bone sarcomas are due to the
15 small level of radium we eat in our food. That's a
16 hypothesis that many people have come up with. And
17 the interesting part is it's remarkably constant. It
18 doesn't change. There's this natural level of bone
19 sarcomas. It doesn't seem to have anything to do, as
20 far as we can tell, with whether you live in a
21 high-radium water area or a low-radium water area.
22 It doesn't make any difference.

23 Well, one reason it probably doesn't is that we
24 all have this background of peanut butter and what
25 have you that we eat, bread, that contains radium.

1 Radium has -- I mean, bone cancer has been
2 studied for many, many years, and bone cancer in
3 terms of radium in the drinking water has been
4 studied, and again, a large study that took place in
5 Illinois and Iowa in the 1960s, a 13-year period,
6 looked at the incidence of bone cancer in communities
7 that had very low radium in their water versus
8 communities that had a higher level radium in their
9 water, and in this particular study, the higher-level
10 water communities have slightly high bone cancer than
11 the low,

12 But the contradiction came when Chicago was
13 included. Chicago drinks water from Lake Michigan,
14 which has .03 picocuries per liter, lower than we
15 could ever get out of water drawn from the earth, and
16 it had the highest level of bone sarcomas, highest
17 incidence of bone sarcomas, the City of Chicago with
18 by far the lowest radium in its drinking water.

19 Q I have just a few other unrelated questions. You
20 mentioned that your book was commissioned by the
21 Department of Energy?

22 A A very good word is paid for, how's that?

23 Q That was my question. They paid for it.

24 A Yeah.

25 Q What was the Department of Energy's interest in your

1 work; do you know?

2 A Yes, very much. See, the Department of Energy
3 inherited the national labs. First, we have the
4 Atomic Energy Commission. Then that was replaced by
5 an organization called ERDA, Energy Development and
6 something association. And then the Department of
7 Energy took over all the national lab. That's the
8 reason that the Department of Energy got in -- they
9 inherited the national laboratories. It wasn't they
10 wanted it, but they got it.

11 Q Did they have an interest, though, in this particular
12 issue?

13 A Well, they had to have. When they -- when they
14 inherited the laboratories, they had to get experts
15 who could decide where the funding should go and what
16 have you, so they had to develop an expertise, and
17 they hired people who knew something in these areas.

18 Ultimately, they gave up on radium, and they
19 decided radium was not an issue, and so the funding
20 for the radium program ended in -- completely
21 ended -- I think it was 1993. That study was
22 terminated. But their interests lie in the fact that
23 it was an ongoing program they inherited.

24 MS. HIRSCH: Can I have just a second?

25 MR. FUHRMAN: Sure.

1 MS. HIRSCH: I did have one final question.

2 BY MS. HIRSCH:

3 Q With respect to deposition Exhibit No. 10, which I
4 believe you testified is a summary of an update of
5 your work since --

6 A Yes, it is.

7 Q -- your earlier testimony to the DNR --

8 A It's a document that I updated; that is, I provided
9 in 1991 a document on the whole subject of radium in
10 humans and its risks. I updated that and that's what
11 document 10 is an update.

12 Q When was document 10 created?

13 A Very recently because you see the work from
14 Finkelstein that I referred to just came out.

15 Q Okay.

16 A So I would suggest that I sent that to you in
17 October -- in October of -- late September or October
18 of this year; do you remember?

19 MR. FUHRMAN: It's been very recent.

20 THE WITNESS: It was very recent I guess
21 it had to be October.

22 BY MS. HIRSCH:

23 Q And did you prepare that at Mr. -- at his request?

24 A I had -- let me give you the history. I was employed
25 by the Illinois State EPA. The Illinois EPA has

1 decided not to contest variances in communities that
2 are asking for a variance because of radium greater
3 than 5 picocuries per liter in the water. And so
4 they went before the Illinois Pollution Control
5 Board, which is a structure in the State of Illinois,
6 they hired me to defend them against the Illinois
7 Pollution Control Board to give reasons why they
8 should not contest variances.

9 And so for them I took the paper I had prepared
10 for Waukesha and updated it and included the work by
11 Dr. Finkelstein from Canada. Then I turned around
12 and told my esteemed friend here, I've got an update
13 on your work. Would you like to have a copy of it,
14 telling him it had gone already to the Illinois EPA.

15 Q So it wasn't at Mr. Fuhrman's request that you
16 prepared it. It was already --

17 A Technically it was not. It was his original document
18 that I updated.

19 Q To your knowledge, has anybody from the Wisconsin DNR
20 had an opportunity to review this document?

21 A I don't know. Depends on what you did with it.

22 MR. FUHRMAN: All right. It went into the
23 mail yesterday, first of all, to you --

24 MS. HIRSCH: Yeah.

25 MR. FUHRMAN: -- and also to Mr. Schmidt --

1 MS. HIRSCH: Okay.

2 MR. FUHRMAN: -- as a follow-up of the
3 original submission of the 1991 paper to him because
4 he was not aware of it. And if you have no
5 objection, I'll just make a brief comment.

6 At the time I became aware of the proposed new
7 rule-making in regard to ground water, I contacted
8 Dr. Rowland and suggested to him that since quite a
9 bit of time has gone by since he prepared his paper
10 in 1991 and a lot of new studies were conducted by
11 him, what was the feasibility of having an update
12 made, and just by coincidence, he had in effect
13 already made the update --

14 MS. HIRSCH: Okay.

15 MR. FUHRMAN: -- for the EPA of Illinois,
16 so --

17 MS. HIRSCH: Okay. Thank you very much. I
18 have no further questions.

19 THE WITNESS: Thank you.

20 (Whereupon, the proceedings concluded at
21 12:05 p.m.)

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23

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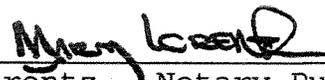
1 STATE OF WISCONSIN)
) ss.
 2 MILWAUKEE COUNTY)

3 I, Mary Lorentz, Notary Public in and for the
 4 State of Wisconsin, do hereby certify that the deposition
 5 of ROBERT E. ROWLAND, PH.D. was recorded by me and reduced
 6 to writing under my personal direction.

7
 8 I further certify that said deposition was
 9 taken at 710 North Plankinton Avenue, Milwaukee,
 10 Wisconsin, on the 26th day of November, 1996, commencing
 11 at 10:15 a.m. and concluding at 12:05 p.m.

12
 13 I further certify that I am not a relative or
 14 employee or attorney or counsel of any of the parties,
 15 or a relative or employee of such attorney or counsel,
 16 or financially interested directly or indirectly in this
 17 action.

18
 19 In witness whereof, I have hereunto set my
 20 hand and affixed my seal of office at Milwaukee,
 21 Wisconsin, this 5th day of December, 1996.

22
 23 

 24 Mary Lorentz - Notary Public
 In and for the State of Wisconsin

25 My Commission expires February 27, 2000.