1993-94 SESSION COMMITTEE HEARING RECORDS

Committee Name:

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

Sample:

Record of Comm. Proceedings … RCP
- 05hrAC-EdR_RCP_pt01a
- 05hrAC-EdR_RCP_pt01b
- 05hrAC-EdR_RCP_pt02

- Appointments … Appt
- **

- Clearinghouse Rules … CRule
- 93hrJCR-AR_CRule_93-188_pt02

- Committee Hearings … CH
- **

- Committee Reports … CR
- **

- Executive Sessions … ES
- **

- Hearing Records … HR
- **

- Miscellaneous … Misc
- **

- Record of Comm. Proceedings … RCP
- **

From

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To

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Room 331 South
State Capitol
P.O. Box 7882
Madison, WI 53707-7882

STATEMENT TO SENATE COMMITTEE ON HEALTH, HUMAN SERVICES, AGING, CORRECTIONS, VETERANS AND MILITARY AFFAIRS
January 5, 1998

May it please the chair. I am Harold H. Fuhrman, one of the attorneys for the City of Waukesha and the Waukesha Water Utility. I am appearing here today in regard to one aspect of Clearing House Rule 93-188 relating to radioactivity in community water systems and enforcement standards and preventative action limits for radioactive substances in groundwater: specifically the proposed standard for radium 226 and radium 228, combined, at 5 pCi/l of drinking and groundwater. The standard is identical with a maximum contaminant level (MCL) that current state and federal regulations prescribe for drinking water. However, the standard for drinking water is in the process of revision by the U.S. Environmental Protection Agency (EPA). That agency has proposed a new maximum contaminant level which is fixed at 20 pCi/l for each of the two radium isotopes: Radium 226 and Radium 228. That revision of the maximum contaminant level is very important to the City of Waukesha and its water utility because the municipal water of the Utility is in conformity with the new maximum contaminant level proposed whereas the Department of Natural Resources (DNR) has informed the City of Waukesha and its drinking water utility that they are in non-conformity with the interim standard of 5 pCi/l of drinking water for Radium 226 and Radium 228 combined. The interim MCL of 5 pCi/l for radium 226 and radium 228, combined, represents a scientifically invalid standard. The cost of compliance with the interim standard would be in excess of 67 million dollars.

In my oral statement to the Clerk of this Committee on January 5, 1998 I indicated that the City of Waukesha would present a scientific consultant, Dr. Robert Rowland, to give testimony on Clearing House Rule 93-188 relating to radium. However, when I received the Notice of today's hearing, I immediately contacted Dr. Rowland in Illinois to ascertain whether there was any possibility of his attending this meeting today. He indicated that he had a conflict and could not attend. I indicated that I would be submitting to this committee a position paper giving greater detail as to the reasons why the City of Waukesha and its Water Utility are opposed to the request of the Department of Health and Family Services.

I had indicated that Dr. Rowland would be absent from the country from February 19th through March 20th of 1998. I request that the committee take this into consideration in fixing a date for a continued hearing if this is feasible. I asked Dr. Rowland whether or not he would be available any time this month. He said he would be available this month any time after January 11, 1998. Therefore I ask for a continuance of this hearing later this month or at a date to be fixed by the Chair. However if this is not feasible I request the opportunity of filing a statement from Dr. Rowland before you take action on this matter.

On December 11th and 12th, 1997 the EPA held a stakeholders meeting relating to radionuclide rulemaking in Crystal City, Virginia, a suburb of Washington, D.C. I attended this meeting together with Dr. Robert Rowland. At that meeting the EPA representatives stated that they would consider any data base that they determine is relevant. They further stated that the EPA would complete the update of health criteria documents and occurrence in January, 1998 and would publish notice of data availability (NODA) in July, 1998, although these two time goals are not definitively fixed. Nevertheless, the very fact that this meeting was conducted by the EPA ..... indicates that the EPA is anxious to have closure on the matter of federal rulemaking in regard to radionuclides. This fact in and of itself indicates the wisdom of patience in regard to this very important area of rulemaking since it involves not only the safety of the public but also immense public funds. In the meantime, the Department of Health and Family Services and the DNR are proceeding with proposed administrative rule changes which would establish a standard of 5 pCi/l of groundwater for radium 226 and radium 228, combined, the existing standard for drinking water and to further adopt the same MCL for drinking water already adopted by the DNR but not by the DHFS.

The City of Waukesha and its Water Utility opposed these changes by appearing at a public hearing that was held by the Department of Natural Resources and Department of Health and Family Services in Waukesha earlier this year. At that time the City of Waukesha and its Water Utility presented the testimony of this scientific consultant, Dr. Robert Rowland. Prior to the hearing the City of Waukesha and the Waukesha Water Utility, pursuant to notice, filed with the DNR, the deposition of Dr. Rowland, and exhibits relating thereto including a copy of a 1994 book by Dr. Rowland entitled, Radium in Humans: A Review of U.S. Studies, commissioned and published by the U.S. Department of Energy. We propose to file these same materials with you.

Notwithstanding the testimony of Dr. Rowland, as well as the testimony of Mayor Carol Opel of the City of Waukesha, the proposed standard for groundwater and drinking water for radium 226 and radium 228 at 5 pCi/l has now been formally recommended to the two houses of the Wisconsin Legislature for adoption.

Now addressing the merits of the proposal before you today, it is necessary for me to review briefly the history of the subject matter as it relates to the City of Waukesha and its Water Utility. In the year 1991 three major events occurred regarding this general subject matter. First of all the U.S. EPA formally announced the new proposed MCL, that is the maximum contaminant level, for radium 226 and radium 228 for drinking water at 20 pCi/l of water for each isotope. The announcement initiated a rulemaking proceeding. This, of course, was after years of study. The hearings on that particular rulemaking proceeding were held in 1991 in both

Washington, D.C. and Chicago. The City of Waukesha and the Waukesha Water Utility appeared at these hearings and presented the testimony of their consultants in support of the scientific correctness of the proposed new maximum contaminant level.

The second major event which occurred in 1991 was the initiation of a rulemaking proceeding by the DNR relating to groundwater. That rulemaking proceeding was analogous to the one that is now occurring here. That rulemaking relating to contaminants in groundwater propose an enforcement standard of 5 pCi/l of radium 226 and radium 228, combined in 1991 just as now. The City of Waukesha and the Water Utility objected to that proposed standard in 1991 as it is doing today in connection with the current rulemaking proceeding for groundwater. Dr. Rowland filed a paper with the examiner and the Radiation Protection Council.

In 1991 Waukesha took the position that the rulemaking in regard to radium 226 and radium 228 should be postponed until after the EPA had completed its own federal rulemaking in regard to radium 226 and radium 228 as it pertains to drinking water. In fact the DNR did not adopt a rule for radium 226 and radium 228 for groundwater in the year 1991. However, now the Department is proposing again to adopt a rule for groundwater making the enforcement standard 5 pCi/l of water for radium 226 and radium 228, combined thus again following the MCL for drinking water for those two isotopes.

Prior to the requested continuation of this hearing after today's proceedings, The City of Waukesha intends to file with this committee a copy of the transcript of a deposition of Dr. Robert Rowland which was taken in November of 1996 for the purpose of preserving his testimony. Along with the transcript, Waukesha will submit exhibits including a 1994 book entitled, Radium in Humans: A Review of U.S. Studies, which was written by Dr. Rowland at the request of the U.S. Department of Energy to set forth the history of the studies of radium in the United States. The book is now the official history of the most intense study of radium by the scientific community covering a period of several decades. Many of these studies were conducted by the Department of Energy at the Argonne National Laboratory under contract with the University of Chicago. Dr. Rowland played a key role in that work and for that reason was commissioned to write the history of it.

In addition to that, the exhibits which we have filed with the DNR also include papers which Dr. Rowland has delivered more recently at Heidelberg and in France reflecting his continuing studies of the subject matter.

The third major event that occurred in 1991 was the commencement of an enforcement action by the DNR against the City of Waukesha and the Waukesha Water Utility to seek compliance with the interim maximum contaminant level for radium 226 and radium 228 at 5 pCi/l

for those two isotopes combined. That litigation was settled by a consent judgment without prejudice and under that judgment enforcement proceedings are in abeyance until 1999 or an earlier time in the event the EPA completes its rulemaking in regard to radionuclides in drinking water before 1999.

At the conclusion of the Federal Rulemaking, the DNR will determine whether it is satisfied with the Federal Maximum Contaminant Level for radium 226 and radium 228. If it is determined that it is not, then the DNR will be at liberty to renew its litigation.

This is essentially a very brief sketch of the background information in regard to the concerns of the City of Waukesha and its Water Utility from a legal and administrative standpoint. We are asking this committee and the Legislature to postpone action on the proposed enforcement standard for radium in groundwater until the EPA completes its federal rulemaking in regard to radionuclides in regard to drinking water. This will be consistent with the spirit of the consent judgment.

For the record the City of Waukesha and the Waukesha Water Utility formally assert for their own account and as parens patriae for their citizens, taxpayers, inhabitants, property owners and rate payers that if the proposed standard is approved that this will infringe the rights of the objectors and their constituents under the Fourteenth Amendment to the U.S. Constitution and under the Wisconsin Constitution, Article I, Sec. 1, both facially and/or as applied by depriving them of property without due process of law.

Once again, I request the Chair and the Committee that this hearing be continued to either a day certain or to a date to be fixed by the Chair for the reception of the testimony of Dr. Rowland and, if feasible, the testimony of Mayor Carol Opel of the City of Waukesha and the reception of written statements, documents, and exhibits. However, I have been informed by your clerk that the Committee must take action within 30 days of receipt of Clearing House Rule 93-188. On the other hand I have been informed that since C.H.R. 93-188 was not acted upon before the end of December, 1997 that the matter has died. Nevertheless, it is our goal to keep the Committee informed since an effort to renew the rulemaking may be undertaken this year again.

Thank you very much.

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Offices In:
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TO: Senator Rodney C. Moen

FROM: Donald P. Gallo, Esq. (#203)

DATE: December 8, 1997

NUMBER OF PAGES INCLUDING COVER SHEET: 3

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Ex. 6

ANL/ER-3

Radium in Humans

A Review of U.S. Studies

R.E. Rowland
Argonne National Laboratory

ANL/ER-3
UC-408

Radium in Humans

A Review of U.S. Studies

by
R.E. Rowland
Environmental Research Division

Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

September 1994

Work supported by the United States Department of Energy,
Office of Energy Research, Office of Health and Environmental Research,
and Assistant Secretary for Environment, Safety, and Health,
Office of Epidemiology and Health Surveillance

DR. ROBERT ROWLAND
DEPOSITION EXHIBITS - 11/26/96

1. Curriculum Vitae of Dr. Rowland.

2. Federal Register notice of rulemaking on Radionuclides in Drinking Water, July 18, 1991.

3. Testimony of Dr. Rowland at Washington, D.C., on September 6, 1991.

4. Testimony of Dr. Rowland at Chicago, IL on September 12, 1991.

5. Statement of Dr. Rowland filed with the DNR and the Radiation Protection Council of the Dept. of Health and Social Services.

6. Radium In Humans: A Review of U.S. Studies, 1994, University of Chicago.

7. Peer review of Exhibit 6 by Dr. David S. Gooden.

8. Paper delivered at Heidelberg, 1994.

9. Paper delivered in France, 1996.

10. Testimony of Dr. Rowland at the Illinois Pollution Board, October 25, 1996.

Robert E. Rowland
700 W. Fabyan Pkwy., Apt. 8C
Batavia, IL 60510

EDUCATION:

B. A., 1947	Cornell College, Mt. Vernon, Iowa. Physics.
M. S., 1949	University of Illinois, Urbana. Physics.
Ph. D., 1964	University of Rochester, New York. Radiation Biology.
M. B. A., 1975	The University of Chicago, Chicago, Illinois. Business Administration.

ACADEMIC HONORS:

1947	Phi Beta Kappa,	(liberal arts).
1949	Pi Mu Epsilon,	(mathematics).
1975	Beta Gamma Sigma,	(business administration).

EXPERIENCE:

1944-45	U. S. Army Air Corps. Meteorologist. Air Traffic Controller.
1949	Cornell College, Mt. Vernon, Iowa. Physics instructor.
1950-62	Argonne National Laboratory, Radiological Physics Division. Associate Physicist.
1962-64	University of Rochester, New York. Senior Technical Associate.
1964-81	Argonne National Laboratory, Radiological and Environmental Research Division. Associate Division Director 1964-67 Senior Biophysicist 1966-83 Division Director 1967-81.
1981-83	Argonne National Laboratory, Associate Laboratory Director for Biomedical and Environment Research.

Ex. 1

PROFESSIONAL SOCIETIES:

Sigma Xi
Health Physics Society
Radiation Research Society
Radiological Society of North America
American Association for the Advancement of Science

PROFESSIONAL ACTIVITIES:

1971-83	National Council on Radiation Protection and Measurement (NCRP).
1976-83	Consultant, Nuclear Regulatory Commission
1979-81	Consultant, James F. MacLaren Limited.
1980	Consultant, National Home Builders Association.
1987-	Scientist Appointee - Argonne National Laboratory.
1989	Consultant, Life Systems, Inc.

PUBLIC OFFICES:

1959-62	Hinsdale, Illinois, High School Board of Education.
1970-76	DuPage County, Illinois, Board of School Trustees.
1985-89	Caldwell County, Kentucky, Library Board.

PUBLICATIONS:

About 50 open literature publications, primarily related to mineral metabolism and the effects of internally-deposited radioisotopes on human beings.

RESEARCH INTERESTS:

Metabolism of human bone.
Deposition patterns of radionuclides in human bone.
Epidemiology of populations carrying internal depositions of radionuclides.

8/94

federal register

Thursday
July 18, 1991

Part II

Environmental Protection Agency

40 CFR Parts 141 and 142

National Primary Drinking Water Regulations; Radionuclides; Proposed Rule

Ex. 2

III-J1.1

TRANSCRIPT OF PROCEEDINGS

RADIONUCLIDES PUBLIC HEARINGS

September 6, 1991
Revision October 28, 1991

At the Marriott Hotel
Crystal City, Virginia

HI-TECH REPORTING RESEARCH INTERNATIONAL
300 I STREET, N.E. #206
WASHINGTON, D.C. 20002
[202] 544-2262

79p.

Ex. 3

1. DR. ROWLAND: I am Dr. Robert E. Rowland, I have
2. a Ph.D in Radiation Biology, and have spent almost
3. all my professional career at the Argonne National
4. Laboratory studying various aspects of the problem
5. of radium in humans. I joined the Laboratory in 1950,
6. became Associate Director of my research division
7. in 1964, Director in 1967, and was appointed Associate
8. Laboratory in 1981. I retired n 1983, and have worked
9. as a consultant to the Laboratory and other
10. organizations since that time. I was member of the
11. National Council on Radiation Protection and
12. Measurements (NCRP) from 1971 until resigned in 1983.
13. In 1969 the Atomic Energy Commission combined
14. all of its funded research studies on radium in humans
15. into one program, the Center for Human Radiobiology,
16. and placed that program at Argonne under my direction.
17. The files in the Center for Human Radiobiology at
18. the Argonne National Laboratory contain the names
19. of approximately 6000 people who acquired the element
20. radium internally. Many of these people acquired
21. radium when internal radium was prescribed by members
22. of the medical profession, a practice popular in the
23. 1920s and early 1930s. Others acquired radium as

1. a consequence of buying and drinking water to which
2. high levels of radium had been added. The greatest
3. number, however, acquired radium when they worked
4. as watch-dial painters, applying a radium-containing
5. paint to watch and clock dials so that the hands and
6. numerals would glow in the dark.
7. Nearly 2400 of these individuals have been
8. carefully studied in the laboratory, both for their
9. radium content and their health status. The ultimate
10. cause of death has been determined for the deceased
11. cases by autopsy or at least by means of a death
12. certificate. (Over 1400 of these measured cases were
13. alive at the end of 1985.) It is known that two
14. distinct malignancies have been induced by high levels
15. of radium, bone sarcomas and carcinomas originating
16. in the mastoid air cells or paranasal sinuses. These
17. latter malignancies have been called "head carcinomas"
18. for brevity. Dose response relationships have been
19. derived and published (1,2,3) for each of these
20. malignancies.
21. I am pleased to be able to speak to you in support
22. of the proposed drinking water standards for Ra226
23. and Ra228. I submitted a statement on this subject

1. to the Honorable Henry A. Waxman on October 10, 1979,
2. which was prepared for and subsequently presented
3. at a public hearing held in Chicago on community
4. water supplies. At that time I proposed that a combined
5. standard of 30 pCi per liter for Ra226 and Ra228 should
6. be adopted for these radium isotopes in drinking water.
7. Since that time new data are available that support
8. my previous position, and make it obvious that the
9. currently proposed standard for the maximum containment
10. levels (MCLs) of 20pCi for Ra226 and for Ra228 provided
11. excellent margins of safety for the public at large.
12. What is this new data? Two recent publications
13. from the Radium Program at Argonne National Laboratory
14. (4,5) have shown that the retention of radium in the
15. human body is dependent upon the level of radium in
16. the body. Those individuals with the lowest levels
17. of radium in their bodies were found to lose radium,
18. 30 to 60 years after they acquired it, several times
19. more rapidly than those with higher levels.
20. The dose delivered from radium in bone, the
21. ultimate resting place of radium retained in the body,
22. to bone cells depends upon the total quantity of radium
23. acquired. Those people who acquired significant radium

1. burdens in their bodies, whether it was as a consequence
2. of painting radium dial watches or clocks, or from
3. the drinking of bottled water spiked with radium,
4. or as an intravenous injection from a physician, did
5. so many years ago. The watch dial industry flourished
6. from about 1915 through World War 11, but major radium
7. uptakes took place only up to the mid-1920s. Radium
8. drinking water was shown in the mid-1930s to be harmful
9. way of medicating oneself (6). The medical uses of
10. radium also terminated in the mid-or late 1930s. Thurs
11. the radium-exposed individuals from whom we have learned
12. the most about radium's toxicity acquired their radium
13. many years ago. Measurement of radium body burdens
14. of most of the radium cases took place in the 1960s
15. and the 1970s; relatively few cases were evaluated
16. in the 1950s and before. Thus most cases were measured
17. 30 to 50 years after they were exposed to radium.
18. The first step in the evaluation of risk to an
19. individual from radium is a measurement of his or
20. her radium body content. As stated above, this
21. measurement is made a long time after the individual
22. acquired their radium. However, to determine the
23. risk it is necessary to know how much radium was

1. actually acquired when the exposure took place. If
2. the time of the exposure is known, then, with a valid
3. retention function, one can calculate back from the
4. recent measurement and determine the initial intake.
5. When speaking of intake, it is necessary to
6. differentiate between oral intake and systemic intake,
7. that is, intake into the circulating body fluids.
8. In a crucial study published in 1967 it was shown
9. that about 20% of radium ingested enters the systemic
10. circulation and is then deposited throughout the
11. body(7). Thus the initial systemic intake, determined
12. from a body measurement extrapolated back to the initial
13. exposure time, represents only 20% of the amount
14. ingested. The remaining 80% that entered by mouth
15. is not absorbed into the blood stream, but is rapidly
16. eliminated from the body.
17. The retention of radium in humans is described
18. by an arbitrary equation known as the Norris retention
19. function (8). This was determined from a group of
20. hospital patients who were given well documented
21. intravenous injections of Ra226 in a mental institution
22. in 1931 (9) and who remained institutionalized for
23. most of their lives. These patients, given injections

1. anging from 70 to about 450 uCi, were measured twice
2. within a few years after their injections and twice
3. more in the 150s. From these measurements it was
4. possible to derive a function that fit these sets
5. of measurements. The retention of this injected radium
6. was expressed as Rt=Ro x 0.54 x t-0.52
7. Here 't' is the time after the injection in days,
8. Ro the quantity injected, and Rt the quantity remaining
9. after 't' days. This function is shown in graphical
10. form in Figure 1 as the fraction of the injected radium
11. remaining in the body as a function of time.
12. All of the U.S. radium cases who have had their
13. radium body content measured, and for whom the date
14. of radium intake is known, have had their systemic
15. intakes calculated by means of the Norris retention
16. function. It was from this calculated by means of
17. the Norris retention function. It was from this
18. calculation of intake that their radium doses have
19. been calculated, and it was from these systemic intake
20. levels that mathematical functions have been derived
21. that related intake or dose to the risk of a
22. radium-related malignancy. That is, all the risk
23. estimates that have been made depend upon these

1. calculations of the lifetime dose to the bones of
2. these cases have been based on their initial systemic
3. intakes and on the gradual loss of radium from the
4. body as predicted by the Norris function.
5. In 1973 a Task Group of the International
6. Commission on Radiological Protection (ICRP) formulated
7. a new retention equation for radium in humans. This
8. was published as an ICPR Report (10), and is known
9. as ICRP 20. This function has not been used to
10. calculate corrected intake levels for the measured
11. radium cases, although it is widely accepted as the
12. best description of the retention of radium in the
13. body.
14. It is known that very high doses of radium, large
15. enough to have a high probability of inducing a
16. malignancy, cause necrosis of bone. Somewhat lower
17. doses were observed to cause blockage of some of the
18. very small blood vessels within bone; such blockage
19. would prevent the loss of radium from these necrotic
20. regions. It wasn't suprising then that in the mid-1980s
21. reports appeared that showed that the loss of radium
22. from the body depended upon the level of radium within
23. the body (4,5). These studies showed that individuals

1. whose radium levels were lower than the Elgin cases
2. lost radium at a higher rate than predicted by the
3. Norris function.
4. The Norris function (8) predicts a rate of radium
5. clearance averaging 1.2% per year in the interval
6. from 30 to 60 years after intake. The studies mentioned
7. above (4,5) found that cases with initial systemic
8. intakes ranging from 4 to 24uCi (calculated by the
9. Norris function) had values of radium clearance greater
10. than 4% per year over this time period. The radium
11. retention function derived in ICRP 20(10) used, for
12. the rate of bone apposition and resorption, that is,
13. bone turnover, a value of 1.5% per year. This is
14. surprising, for the ICRP document states that the
15. turnover rate is a property of bone itself, and not
16. dependent on the radioelement under consideration.
17. It states that, for compact bone, the rate should
18. be 2.5% per year and uses this value to derive retention
19. equations for calcium and strontium, but uses only
20. 1.5% per year for radium.
21. The consequences of these findings have not been
22. fully absorbed by the radiobiological community. They
23. imply that when an individual containing a low level

1. of radium is measured, the systemic intake, calculated
2. by means of the Norris function is actually lower
3. than the true systemic intake, because that individual's
4. radium was eliminated from the body faster than
5. predicted by the Norris function. This, is turn,
6. indicates that the low dose cases used in the analysis
7. of risk versus intake (1,2,3) actually had intake
8. levels greater than they were credited with in those
9. analyses.
10. I have recalculated the ICRP 20 retention function
11. for radium with the approved bone turnover rate of
12. 2.5% per year. The fractional retention predicted
13. by this corrected function is shown in Figure 1 with
14. the uncorrected ICRP 20 equation and the Norris
15. function. It will be noted that all of these functions
16. predict essentially the same radium retention for
17. the first ten years after acquisition. After that,
18. the ICRP 20 functions predict lower retention than
19. the Norris function, with the corrected function
20. predicting the most rapid loss of radium. If the
21. corrected ICRP retention function is used to calculate
22. initial systemic intakes for low level radium cases
23. the values obtained will be significantly larger than

1. those calculated by the Norris function. The table
2. below shows, for several different measurement times,
3. the ratio of the Norris prediction of the fraction
4. of the radium retained to the prediction from the
5. corrected ICRP 20 function. These ratios are also
6. equal to the factor by which the Norris function
7. underestimates the actual initial systemic intake
8. at various times after radium was acquired.

9. | TIME FROM EXPOSURE TO MEASUREMENT | RATIO: NORRIS/CORRECTED ICRP |
|---|---|
| 10. 1day | 1.21 |
| 11. 10day | 1.22 |
| 100day | 0.99 |
| 12. 1year | 0.90 |
| 10years | 1.06 |
| 13. 20years | 1.43 |
| 30years | 1.87 |
| 14. 40years | 2.39 |
| 50years | 3.04 |
| 15. 60years | 3.86 |

16. From this table we see that a radium case, with
17. an intake in the range of 4 to 20 uCi (as calculated
18. by the Norris function), would have a true intake
19. almost twice as large as calculated with the corrected
20. ICRP 20 function, if the measurement of radium took
21. place 30 years after the radium was acquired. Had
22. the measurement taken place 60 years after acquisition
23.

1. the true intake value would be nearly four times as
2. large as the calculated by the Norris function.
3. I have examined the files at Argonne and found
4. that the average time from first entry into the dial
5. painting industry to measurement of body radium was
6. 40.2 years for 1369 women who were measured while
7. alive, calculated by the Norris function) of less
8. than 100 uCi. The correction to be applied to the
9. Norris intakes at this interval is factor of about
10. 2.4.
11. All of the estimates of risk from internally
12. deposited radium have made use of the Argonne values
13. of intake or bone dose, all of which have been
14. calculated with the Norris function. It is now clear
15. that this retention function is only applicable to
16. radium retention n a radium damaged skeleton, where
17. the initial intake was measured in hundreds of
18. microcuries.
19. The ICRP 20 retention function, based as it was
20. on metabolic parameters, has been considered more
21. realistic. We now know it too is in error, for it
22. (inadvertently?) used too low a value for bone turnover.
23. In the Federal Register for July 18, 1991 (11)

are concise descriptions of the methodology that has led to the proposed MCLs for Ra226 and Ra228. Both an epidemiological and a dosimetric approach were employed in deriving the proposed MCLs. My observation that the retention equation used for radium, the Norris function, is not a valid description of ingesting radium from drinking water, will alter the conclusions from each of the alteration is such that MCLs derived with corrected values of initial intake will be <u>greater</u> than those currently proposed.

When corrected values of the intitial systemic intake are calculated for the low level radium cases with intake values calculated by the Norris function of less than about 50 uCi of radium, the epidemiological approach will yield dose response functions even steeper than those currently used (1,2,3). For example, in (2), where a dose-squared dose-response function for bone sarcomas was derived, it means that all cases currently thought to have initial systemic intakes below, say 25 uCi, probably have intakes about 2.4 times higher than assigned. Cases as high as 50 uCi may actually have intakes near 100 uCi. Thus more than 1200 low dose cases (among whom no bone sarcomas

1. were observed) in the analysis of reference (2)
2. actually have higher intake values than were used
3. in the derivation of the dose response function. This
4. increase in intake values will make the steep dose
5. response curve observed and now described by the
6. dose-squared function even steeper, and will make
7. it even more unlikely that any linear function will
8. adequately fit this set of data.
9. In contrast, if a risk assessment based on
10. dosimetric models is made, using the corrected ICPR
11. retention function, the lifetime dose from a given
12. intake of low level radium will be lower, for radium
13. is lost from the body at a more rapid rate than
14. predicted by the Norris function. As a consequence
15. of the lower dose delivered over a lifetime, the MCLs
16. for the radium isotopes derived from these lower doses
17. would be increased to values larger than presently
18. proposed.
19. I personally prefer to see standards set with
20. epidemiological rather than dosimetric data. As
21. indicated in the referenced EPA document (11), the
22. RADRISK model (12) had to be "...adjusted for
23. over-prediction of leukemias, lack of separation

1. prediction of head carcinomas by radium-226, and for
2. under-prediction of bone dose and sarcoma risk by
3. radium-228." With the epidemiological data one is
4. always handicapped with poor statistics, yet one is
5. dealing with real human data, flawed as it may be.
6. The adjustments to the dosimetric model were based
7. on the observed human experience, and are thus based
8. ultimately on the epidemiological data.

9. CONCLUSION

10. As mentioned in my introduction, in 1979 I
11. testified in opposition to the Interim standard of
12. 5 pCi for Ra226 and Ra228 combined as set in 1975.
13. In the conclusion of that statement I said:

14. "The acceptance by the ICRP of the
data acquired over the past 50 years
15. on the metabolism of radium in humans,
and its use in formulating the Annual
16. Limit of intake for the radium isotopes,
results in a derived MPC, far greater
17. than previously proposed. Even reducing
this MPC, derived for those occupationally
18. exposed, by a factor as large as loo would
result in a level for the general public
19. of 26 pCi226Ra/liter and of 33 the levels
for radium in drinking water supplies
20. ought to reflect the considered opinion
of the members of this organization."

21. This is essentially what has now been proposed,
22. and I commend those responsible. I strongly support
23. the proposed MCLs of 20 pCi for both Ra226 and Ra228.

1. These are safe levels for the general public, as has
2. been demonstrated by the analyses performed by the
3. EPA. They will be seen to be the low level radium
4. cases, calculated by a corrected version of the
5. retention equation of ICRP 20.
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NORRIS, ICRP 20, AND CORRECTED ICRP 20 RETENTION FUNCTIONS

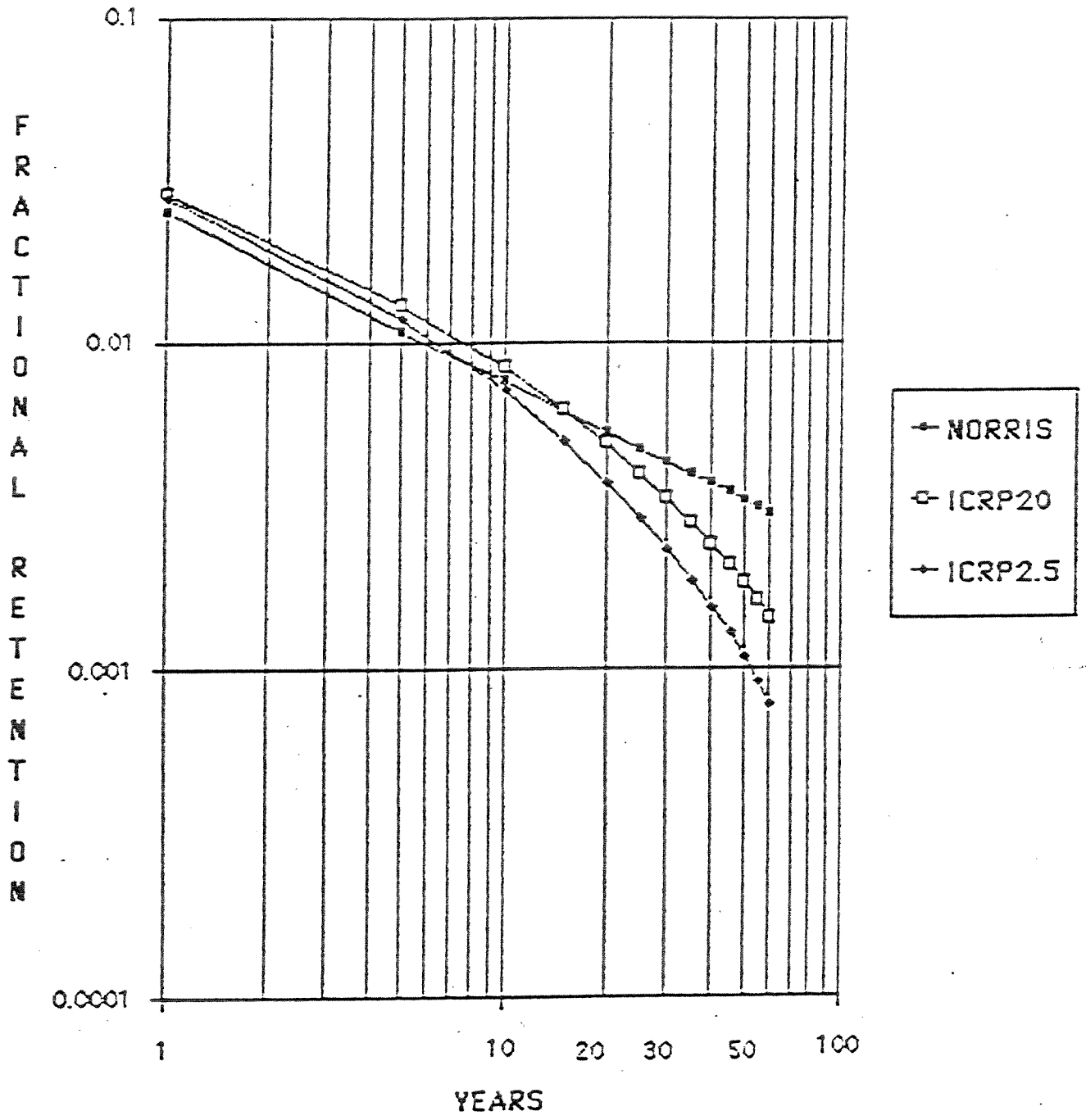

FIGURE 1

ORIGINAL

HEARING ON PROPOSED REGULATIONS
FOR RADIONUCLIDES IN DRINKING WATER

REPORT OF PROCEEDINGS of hearing held at the Federal Building, Chicago, Illinois, on September 12, 1991, at 9:00 a.m. before Panel Members Greg Helms, Neal Nelson, and Karen Clark.

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Ex. 4

11 So without further ado, I will call
12 upon Dr. Roland to give his remarks.
13 DR. ROLAND: Thank you. Let me introduce
14 myself by saying I am Dr. Robert E. Roland. I have
15 spent my professional career primarily at the
16 Argonne National Laboratory ~~which~~ where I have studied
17 metabolism, the removal of radium from the human
18 body, and I have been involved in a very large
19 epidemiological study which was aimed at gathering
20 together all of the people we knew of that were
21 exposed to radium in the United States and to follow
22 them throughout their remaining lifetimes.

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1 I presented a statement last week at
2 the EPA hearing in Washington, and that statement
3 contains my credentials and a little bit of a
4 description of the work. I do not intend to go into
5 it today.
6 Last week in Washington I commended
7 the EPA on raising the standards for the two radium
8 isotopes from a combined level of five picocuries
9 per liter to individual levels of 20 picocuries per
10 liter. I think that is a wise move.
11 I further presented new data which
12 indicates that the methodology they use was slightly
13 in error, and I have found that the retention
14 function for radium which is basically a part of the
15 rad risk computer model that they use, I found that
16 that formulation which was put together by the ICRP
17 in 1973 is in error, and I have recalculated that
18 function using more nearly correct data.
19 In essence what it does, it removes
20 radium at low levels from the body much more rapidly
21 than we previously thought. Now, those low levels I
22 am talking about are still a hundred thousand times

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1 higher than the levels we acquire from radium in
2 drinking water, but it's the lowest level in which
3 we have measurable data in human beings.
4 So with the adjusted retention
5 formula for radium, the calculated dose from a
6 hypothetical intake of radium is going to turn out
7 to be lower over the lifetime than was assumed.
8 Therefore the risk over the lifetime will be lower
9 than has been calculated.
10 Therefore the 20 picocurie maximum
11 contaminant levels will be safer than they think.
12 So I am in a position to ~~log~~ Laud them for raising the
13 levels and to tell them that they are even safer
14 than I think they are. I think the move is a move
15 in the right direction.
16 Today however, I am here to take
17 issue with the EPA, and I want to take issue
18 specifically over the maximum contaminant level
19 goals. The goals for the 2 radium isotopes are set
20 at zero, and I think these goals are improper goals
21 for two reasons.
22 By setting a goal of zero, the

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1 implication is made that it is achievable, and by
2 setting a goal of zero the implication is made that
3 it's worthwhile. I think both of these
4 implications are wrong.
5 Now, it would be an easy matter
6 apparently to reduce the interim standard of 5
7 picocuries per liter to zero. Sounds easy anyhow.
8 Five to zero isn't much of a step. But I will
9 recall for you that it is a very big step, and it is
10 indeed an impossible step, and if you will allow me
11 to -- I produced this in rather a hurry in order to
12 make this meeting today. I am hoping you can read
13 this. What this thing is supposed to say is how
14 many radium atoms are in our drinking water.
15 Let's go back and learn a little
16 science or renew a little science. For your
17 purposes, I put down as 6.025 times 10 to 23 atoms
18 per gram atomic waste, and for ease, I am going to
19 talk about radium-226.
20 So I can calculate how many atoms are
21 found in a mass of radium-226. Radium-226 is easy
22 because one gram is equal to one curie, and it makes

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1 the translation very easy.

2 So I say there are 2.7 times 10 to

3 the 21st radium -- 226 atoms per gram. Now, if we

4 talk about water containing five picocuries per

5 liter to meet the present interim standard, we can

6 very easily calculate by transferring from grams to

7 picocuries and throwing in a factor of five

8 picocuries, and we find we have 1.3 times 10 to the

9 10th radium atoms per liter at the present interim

10 contaminant level.

11 Now, what is the meaning of that.

12 Well, if you could see this, maybe we could help a

13 little bit like this. They tell us the BAT, best

14 technology available for removal of radium is

15 reverse osmosis which is supposed to remove 98

16 percent of the radium. So if we pass our five

17 picocuries of water through a good reverse osmosis

18 plant, you are going to leave two percent of the

19 radium or 2.6 times 10 to the 8th radium atoms per

20 liter of water. Two plants in series or set at

21 twice the cost would get you down to five times 10

22 to the 6th atoms per liter.

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1 So I find if I request that my
2 community buy and build and operate six plants in
3 series, we can get down to about one radium atom per
4 liter, but that is not zero. And I think you all
5 quickly realize it's impossible to achieve zero by
6 any process of this nature that takes out any
7 fraction of what is there. And I propose that will
8 always be the case. There's no process that will
9 take out all, if by all we mean down to no atoms in
10 our sample. With that, I will turn this thing off,
11 or I'll let you turn it off.
12 Thus I have tried to point out that
13 zero as a goal sounds easy and sounds well on a
14 piece of paper, but in practice it's not possible.
15 But more importantly the very fact of saying that
16 it's a goal seems to imply it's worthwhile. So what
17 we are telling communities is to get the radium out
18 of the drinking water so as we reduce the risk,
19 hypothetical risk, and if those hypothetical cancers
20 that we just heard which incidentally, he was a hard
21 act to follow -- he did a very good job. But
22 getting back to is it worthwhile.

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1 Let me recall for you that we are
2 privileged here in the Midwest to have lots of
3 problems with radium in our drinking water, and
4 several other areas of the country have problems
5 with radium in drinking water as well.
6 But I believe if we look at the
7 entire U. S. population, these are local problems.
8 Most of the rest of the United States has to get its
9 radium from its food. And how much radium does one
10 get from one's food.
11 Well, if we pay attention to what the
12 MCRP says, I looked at New York City where a lot of
13 studies have been made, and I believe the numbers
14 are 1.8 picocuries per day radium-226, and 1.2
15 picocuries per day radium-228 which adds up to three
16 picocuries per day in our food.
17 Now why, I ask, should we drive the
18 level of radium in drinking water down to a
19 hypothetical zero when we are already all exposed to
20 approximately three picocuries per day in our food.
21 I am not going to suggest that the
22 EPA address the problem of removing radium from

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1 food. But it's present in all foods. All foods
2 that I have ever seen analyzed do contain radium.
3 Grain and cereals are rather high So
4 your breakfast cereal is a very good source. Start
5 out your day with your little jolt of radium. I'm
6 not being facetious.
7 The national average of radium
8 content I think is about 30 picocuries total body if
9 you live in a region where there is not elevated
10 radium in the water.
11 So it seems to me it's not really a
12 worthwhile endeavor for a commuity to spend millions
13 of dollars to drive their radium levels down to a
14 hypothetical level of zero when they are not doing
15 anything with that money.
16 Now, some people don't like
17 cost-benefit ratios. But there's a different kind
18 of cost-benefit ratio We all employ only we don't
19 use that name.
20 When I tell you that six expensive
21 reverse osmosis plants will do the job you smile.
22 Why do you smile? Because you realize that is a

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1 ridiculous expense. You are making a mental cost
2 benefit analysis.
3 You don't have a piece of paper in
4 front of you. You don't say this is a cost-benefit
5 analysis. You say that is ridiculous. But that is
6 a cost-benefit analysis. Actually anything to do
7 with dollars and cents in our lives involves a
8 cost-benefit analysis.
9 Now, what I would like to suggest is
10 that we set a goal, maximum contaminant level goal
11 of a realistic and yet safe number, and I don't know
12 what that is. I would say, for example, how about
13 .01 picocuries of each of the radium isotopes per
14 liter of water.
15 For reference the last time I saw
16 numbers on Lake Michigan, it had .03 picocuries per
17 liter radium in that water which the city of Chicago
18 uses. So .01 is a very low number as far as I'm
19 concerned. I think the City of Chicago would rise
20 up in horror if they were told they had to take the
21 radium? uranium out of the water.
22 But the real point of the matter is,

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1 if we set a level that is attainable, if we set a
2 level that was thinkable about, you could achieve
3 .01. That probably would be a much more logical and
4 intelligent way of setting a goal.
5 Perhaps an alternative way would be
6 to say we don't express risks that are smaller than
7 one in a million. Perhaps we ought to turn around
8 and calculate that level of radium in the water
9 which hypothetically would give us a risk estimate
10 of the order of one in a million and use that as a
11 goal of a radium concentration in water. Just a
12 passing idea.
13 But I think the point I am making
14 should be across by this time, zero is a very poor
15 level to set even though everybody knows that radium
16 is a carcinogen, and all radiation is dangerous.
17 If that is the case then perhaps we
18 better turn back and look a little more about radio
19 biology and ask the EPA or the FDA what they are
20 going to do about potassium in our food. Now, we
21 all the know that potassium K40 is of very low
22 abundance in natural potassium, .0118 percent.

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1 What we also ought to realize is that
2 potassium is one unnecessary building block in the
3 numan body. Potassium exists in the so-called
4 standard person at a level of about 140 grams, and
5 at that level the potassium 40 is the largest single
6 source of radiation dose to the human body from
7 internal emitters, the largest single source.
8 So we are beating our heads to remove
9 a little bit of radium from the water, but if we
10 were serious, sincere, and logical, we would ask
11 someone to take the potassium out of our bananas.
12 Now, I was at the meeting last week in
13 Washington, and I would like to comment on some of
14 the statements that were made from the floor.
15 Certain testimony that we heard, it was alluded to
16 the fact that in the state of Iowa, increased
17 bladder cancer and lung cancer was observed in
18 males, and increased breast cancer and lung cancer
19 in females who were supposedly exposed to "high
20 radium levels" in drinking water.
21 Further, it was further alleged that
22 there was an association between radium in ground

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1 water and leukemia in certain counties in Florida in
2 which a certain percentage of the wells had been
3 measured and found to contain "elevated levels of
4 radium."
5 Now, I would like to call attention
6 to the fact, and I am sure the EPA is well aware of
7 this, that these studies have been analyzed,
8 reported upon, discussed in bare form. They are
9 there for all to see, and in essence they have been
10 ignored.
11 Why? It turns out that breast cancer
12 in females has been looked for in the several
13 thousand measured radium cases in the United States,
14 and in certain plants, dial plating plants, there
15 has been observed an increase in breast cancer. And
16 in other dial plating plants that increase is not
17 present.
18 The best theory is that breast
19 cancer, if it is truly elevated in radium dial
20 platers, is probably due to the external radiation
21 dose they got when they sat with a vial of paint in
22 front of them at a desk and painted the watch and

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1 clock dials.

2 The proximity of the paint to the

3 breasts, the fact that they worked in a contaminated

4 environment, and by that I mean contaminated because

5 back in the dial painting days, there were not

6 health physicists. There was no clean up of

7 material, and those dial plating plants were

8 unbelievably rich in radium, in the cracks in the

9 floor, on the walls, and everywhere, and as you may

10 remember, the clothing that the dial painters wore

11 actually did glow in the dark due not to the radium

12 but the paint that they had all over them.

13 But it is also an interesting fact

14 that when it was learned that dial painting was not

15 good for your health, and it was suggested that the

16 painters stop sharpening up that brush by putting it

17 in their mouths to make a sharp tip, not one dial

18 painter ever contracted a radium-induced malignancy

19 thereafter. That date was 1925.

20 So by the simple expedience of

21 saying, don't eat the paint, they prevented the

22 intake and cleared up the problem for the dial

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1 painters.

2 To go on, lung cancer has not been

3 elevated in those exposed to radium in our studies

4 at Argonne, and I have given a reference to the most

5 recent report on that. Leukemia has always been

6 associated with radium by those who don't know about

7 the radium studies, but the truth of the matter is

8 there's no excess of leukemia in the entire

9 population of radium exposed individuals.

10 Radium goes to bone. It's buried in

11 bone, and evidently very few of the alphas ever

12 reach sensitive tissues that might indeed induce

13 leukemia, and radium does not induce leukemia no

14 matter what you hear.

15 Our excess is non-existent. We see

16 the same amount of leukemia in radium patients as

17 you would expect in the normal population.

18 Finally, I have very little data on

19 bladder cancer in radium cases. Let me point out to

20 you that radium is a very unique element. It is

21 excreted by the bowel, and I find it hard to imagine

22 how one is going to get bladder cancer from the

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1 alphas emitted by radium in its daughters when
2 radium is not passed through the kidney to the
3 bladder. So I have discounted the fact that they
4 see an excess of bladder cancer in certain areas of
5 Iowa.
6 In other words, what I have said to
7 you today, I approve of the radium levels as
8 proposed at this time by the EPA. I am violently
9 opposed to the goals as stated as zero because I
10 think they are illogical both in terms of
11 achievement and the validity of trying to achieve
12 anything that level while we are exposed to so many
13 other sources of internal radiation, and I have made
14 a few comments to the effect that some of the
15 studies, so-called epidemiological studies of radium
16 related to elevated water supplies all seem to be
17 flawed.
18 No such study has ever seen an
19 increase in those malignancies that are definitely
20 and without a shadow of a doubt due to high levels
21 of radium which are the bone cancers, the carcinomas
22 that arise in paranasal sinuses, and arise in

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1 mastoid air cells.

2 There's not a doubt in the world that

3 high levels of radium do indeed induce these

4 malignancies. But high levels of radiuim refer to

5 intakes of the blood in the order of 50 or more

6 microcuries, and of course the microcurie is a

7 million times higher than a picocurie.