UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	
	)	
GPU Nuclear Corporation	)	Docket No. 50-320-OLA
(Three Mile Island Nuclear	)	(Disposal of Accident Generated
Station, Unit 2)	)	Water)
	)	
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AFFIDAVIT OF DR. CHARLES W. HUVER (CONTENTION 5): FURTHER CONSIDERATIONS OF THE BIOLOGICAL EFFECTS AND HEALTH HAZARDS OF TRITIUM

Charles W. Huver

Dated: October 10, 1988

Sworn and subscribed before me on this 10th day of October, 1988.

ROBERT D. PAULSON
MY COMMISSION EXPIRES
Sept. 1, 1991

Robert D. Paulson
Notary Public
Winnebago County, Iowa

INTRODUCTION

It is clear that based upon the biological evidence that tritium is a classic paradigm of being a widespread and serious contaminant of the environment whose significance has often been ignored or not fully realized. It has unfortunately often been downplayed as a biological and health hazard by those whose support of nuclear technology overshadows their concern for public health (Hurver, et al., 1979).

DISCUSSION

In Contention 5, the Joint Petitioners hold that neither detailed nor accurate information was given in the PEIS to allow decision makers and the public to determine the effects of this proposed action on public health and safety, as required by NEPA (Memorandum and Order, ASLBP No 87-554-04-OLA).

With reference to subpart (d), I would like to expand upon the allegation that the serious biological effects of tritium have been underestimated. An examination of PEIS Supplement No. 2 and the affidavit of Dr. Hans Behling reveals that most of the literature on the biological and health hazards of tritium has been omitted and ignored with the net result that the serious genetic, developmental, carcinogenic, and immunologic effects of tritium exposure have been seriously underestimated.

It is often difficult to separate genetic effects from developmental and teratogenic effects of radiation exposure. For example, the

relatively high incidence of microcephaly observed by ABCC in children of survivors of Hiroshima and Nagasaki who were in-utero at the time of the explosions are probably due to developmental effects but may have a genetic component (i.e., damage to the DNA of critical stem-cells in the embryo). At considerably lower levels of exposure (Torok, Schmahl, Meyer, and Kistner, 1979), pregnant mice were injected with single injections of 0.07 mCi tritium per g body weight during organogeny, the resulting offspring displayed a significantly decreased weight of brain and genital tract organs. At 4.5 months postpartum the number of oocytes was markedly reduced and the epithelium of the seminiferous tubules was in a state of disintegration. Histological examination revealed retardation of the prosencephalon and marked hypoplasia of the gonads.

At still lower levels of exposure, experiments at the Harwell Radiobiology Unit (Carr and Nolan, 1979) showed a reduction in the testis mass of the mouse following single injections of tritiated thymidine (1.0-20 μCi tritium/g body mass) or tritiated water (10-40 μCi tritium/g body mass). The investigators reported a progressive loss in mass of up to 30% after 4-5 weeks followed by an irregular recovery which in the case of tritiated-thymidine-injected mice was more delayed. Calculations suggested that tritium from tritiated thymidine "fixed" in the testis was about twice as destructive of testis tissue as the more uniformly distributed tritium from tritiated water.

When the cumulative genetic effects from tritium exposure of male mice were studied over several generations a trend toward reduction in the

subpopulation of offspring propagated from parents exposed to tritiated water or tritiated thymidine was observed (Mewissen and Ugarte, 1979). At each generation male breeders either received a single injection of tritiated thymidine (1 uCi/g of body weight) or were exposed for five weeks to tritiated drinking water (10 uCi/ml). Mating studies showed that, "preimplantation loss values were significantly increased in experimental versus control sublines." Dose estimations were 3.7 rads from tritiated water and 3.9 rads from tritiated thymidine.

The discussion of mouse oocyte studies by Dobson and associates in the affidavit of Dr. Hans Behling misses the three most important findings of the studies: 1. the RBE (relative biological effectiveness) of tritium compared to gamma radition varied inversely with dose (at gamma ray doses of 40 rad it was 1.6 while at gamma ray doses of a few rads the RBE of tritium rises to approximately 3 (Dobson and Kwan, 1976); 2. at levels of only 0.085 uCi/ml, "a level substantially below those reported previously to cause measurable biological effects in mammals, a significant decrease was still observed " (Dobson and Cooper, 1974); and 3. "no evidence of a threshold was found" (ibid.). These results appear to have important relevance to the proposed release of atmospheric tritium at Three Mile Island.

Unfortunately, we do not have good data for comparing the mouse oocyte susceptibility to tritium with that for human oocytes.

The increasing RBE with decreasing tritium dose may well explain the results reported for human leucocytes (Hori and Nakai, 1978) for

very low dose exposures to tritium. Cultures of human leucocytes were chronically exposed for 48 hr to tritiated water and tritiated thymidine over a broad range of tritium doses. The dose response was measured by chromatid breaks per cell. It was found that at a higher dose range the yields of chromatid breaks increased linearly with dose, while those at lower dose levels were significantly higher than would be expected by a downward extrapolation from the linear model. These results also appear to have relevance to the proposed tritium evaporation project at Three Mile Island.

Very low level developmental effects have been described for embryos of the goose barnacle, Pollicipes polymerus (Abott and Mix, 1979). Barnacle embryos were reared in media containing a wide range of tritiated water concentrations. Developmental effects were observed at concentrations as low as 7×10^{-6} uCi/ml. This level is very close to the ICRP-2 MPC for H-3 (H_2O) of 5×10^{-6} uCi/ml.

The biophysicist Li has calculated that the energy released by the disintegration of one tritium nucleus located in a chromosome is sufficient to produce a chromosome break, thus one would expect some genetic effects at the lowest levels of tritium exposure. Indeed, calculations (Oliver and Lajthe, 1960) on the decay of a tritium atom within the cell nucleus produces a dose of about 170 rad to a sphere of tissue 1 um in diameter. Some genetic anomalies are relatively harmless and in rare instances may be beneficial, but most are harmful and some are lethal. It is therefore expected that the proposed release of atmospheric tritium at

Three Mile Island will lead to some harmful genetic changes in exposed humans and other animals.

The carcinogenic effects of tritium have been studied to a lesser extent than its genetic and cellular effects; however, enough laboratory evidence is available to regard tritium as a confirmed carcinogen. That tritium can cause increased tumore formation in mice has been well demonstrated (Hisoc, et al., 1961; Baserga, et al., 1962). Upon injection of 1 uCi/g of tritiated thymidine, they found that significantly more of these experimental animals died from tumors than did controls. A Federal Republic of Germany research team (Török, et al., 1979) has reported that high levels of tritiated water (0.27 mCi/g) injected into female mouse embryos resulted in high levels of ovarian tumors. In exposed offspring at 18 months, there was a five-fold increase in ovarian tumor incidence over controls.

Lower level carcinogenic effects of tritiated thymidine have been reported for mice (Mewissen, 1970; Mewissen and Rust, 1973). Tritiated thymidine was injected postnatally at a range of 0.3 to 1.5 uCi/g. Experimentals showed a statistically significant increase (chi-square test at the 0.05 level) in overall tumor incidence than control animals. The increase in overall tumors was largely attributed to enhanced lymphosarcoma incidence. No statistically significant dose-response relationship was found for tumor incidence rates and the lowest dose was often more effective than the highest dose in inducing tumors, so there was some evidence of a paradoxical effect. This effect may

be due to inverse relationship between RBE and dose described earlier for tritiated thymidine (Dobson and Kwan, 1976).

Studies of the impact of tritium exposure on the immune system have been relatively few in relation to the number of investigations of the genetic, cellular, and carcinogenic effects of tritium. Beta rays of tritium were found to be more effective than gamma rays in causing damage to the bone marrow of rats (Furchner, et al., 1953). Similarly, beta rays of tritium were more effective than gamma rays in producing thymic and splenic atrophy in the mouse (Worrall, et al, 1954). When the effects of tritiated water on splenic and thymic atrophy in the mouse investigated after only five days of exposure (Storer, et al., 1957), a splenic atrophy RBE of 1.32 and a thymic atrophy RBE of 1.52 were reported. However, their data has been corrected (Johnson, H.A., 1973) for the omission to record some 5% of organically-bound tritium to yield a splenic atrophy RBE of 1.65 and a thymic atrophy RBE of 1.90 as upper limits when related to the effects of X-rays and cobalt-60 gamma rays. Johnson (ibid.) concluded that the present quality factor of 1 for tritium be changed to 2 for estimating the biological risks from an absorbed dose. He did not consider the considerable corpus of evidence for a much higher RBE level when the tritium has been incorporated in DNA or one of its precursors such as thymidine.

A Russian research team (Moskalev, et al., 1973) from the Institute of Biophysics of the Ministry of Health have investigated the RBE values of tritium in relation to the gamma radiation of cesium-137. When declines of lymphocytes (leukopenia) in peripheral blood and

decreases of thymus and spleen weights were studied the RBE of tritium oxide at acute doses was between 1.45 and 1.93. They attributed the biological damage of tritium, "to the fact that it develops 10 to 30 times as great ionization density per unit tissue volume as X- or gamma radiaiton."

The declines in the lymphoid system shown for tritium exposure would expected to be a contributing factor in the etiology of radiation induced cancer for we know from immunodepressant studies in relation to organ transplantation and from AIDS research of the powerful role of the immune system in protecting the body against the growth of cancer foci.

CONCLUSIONS AND RECOMMENDATIONS

1. In the evaporation proposal at TMI the radioisotope of critical concern is tritium because strontium would be concentrated in the evaporator bottoms.

2. The organs of critical concern are the gonads because of the extremely damaging effects of tritium when localized within or near chromosomes in the cell nucleus of germ-line cells.

3. Genetic mutation and cancer induction are two health hazards generally associated with chromosomal alterations, on microscopic and submicroscopic levels, which would be expected to increase in the populated areas surrounding TMI if the evaporation alternative is chosen. Conventional radition dose and cancer risk estimates are likely to

underestimate greatly the mutagenic and carcinogenic effects of tritium because of the extremely damaging potential of even one tritium atom disintegrating within a cell nucleus.

4. The present quality factor (1) and MPC levels for tritium far underestimate the potential for biological damage of this isotope when it becomes bound to the tissues and cells of organisms (particularly food-chain organisms) and especially when it becomes incorporated into the DNA molecule.

5. I recommend proplonged protective storage at the Three Mile Island site in new tanks in an area bermed to protect from accidental spillage to the river. The length of such on-site storage should be as long as possible with consideration for tank integrity and isolation from the surrounding population.

Respectfully submitted,

Charles W. Huver, Ph.D.

Charles W. Huver

Dated: October 10, 1988

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Third Set of Comments Relative to Treatment and Disposal of 2,100,00 Gal of Contaminated Water at TMI-2

by
Karl Z. Morgan
September 30, 1988

A. Historical-Factors Leading to Conclusion That the Licensee is Not Capable of Evaporating the TMI-2 Contaminated Water in a Safe Manner

1. The Amount of Contaminated Water is Unknown and is Likely to Exceed 2.1×10^6 gal.
    a. Reports have given the amount of this water as 2.1×10^6, 2.2×10^6 and 2.3×10^6 gal.
    b. From my own experience in cleanup operations in Oak Ridge, Tenn. I have found the contaminated water almost always exceeds the estimates in spite of efforts to keep it to a minimum

2. The Quantity of H-3, the Principal Radionuclide in Terms of Activity (μ Cis) to Be Released to the Enviornment, is Unknown and Given Erroniously.
    a. The following values are given .07, 0.13, 0.19 and 2.1 μ Ci/mil. This is a range of 30 in the amount of H-3 and in the associated dose to members of the public.

        I recognize that it is difficult to make an accurate theoretical estimate of the H-3 present from the MW-hrs., the B in the reactor as a function of time and from information on other stable elements in the primary and secondary water systems but proper sampling techniques certainly should reduce the uncertainty to less than a few

percent and not 3,000%!

I recognize that although H-3 in the PWR is produced principally by the ^{235}U (fission)^{3}H + other f p's, $^{10}B+N \rightarrow {}^{8}Be+{}^{3}H+0.2MeV$, $^{11}B+N \rightarrow {}^{9}Be+{}^{3}H+9.6\ MeV$, $^{10}B+N \rightarrow 2\alpha+{}^{3}H$ and $^{10}B+N \rightarrow {}^{7}Li+N+{}^{3}H$, there are many other reactions contributing to H-3 production such as $^{2}H+N \rightarrow {}^{3}H$, $^{14}N+N \rightarrow {}^{12}C+{}^{3}H$, $^{1}H+N \rightarrow {}^{2}H({}^{2}H+N \rightarrow {}^{3}H)$, $^{6}Li+N \rightarrow \alpha+{}^{3}H+4.69MeV$. It is for this reason I always give more credulence to properly conducted sampling rather than to theoretical estimates. Why such poor sampling?

3. The Quantity of Other Radionuclides in the Processed Water (Just Before Evaporation) Has Not Been Determined with Sufficient Accuracy.

For Example Sb-125 is given as 6.2×10^{-7} and $<1.1\times10^{-7}$ μCi/ml, Cs-137 as 800×10^{-8} and 7.6×10^{-8} μ Ci/ml, Co-60 as 32×10^{-8} and 8.4×10^{-8} μ Ci/ml, Pu239/240 as $<3.7\times10^{-8}$ and $<1.2\times10^{-8}$ μ Ci/ml, C-14 as 3000×10^{-7} and 2.3×10^{-7} μ Ci/ml, Tc-99 as 25.0×10^{-8} and 1.6×10^{-8} μ Ci/ml. I consider these uncertainties as serious. Cs-137 and Co-60 are among the more important gamma emitters (external dose) in the evatorator bottoms and the residuals of the SDS and EPICOR-II processing before the evaporation so a difference of the Cs-137 dose by a factor of > 100 and of the Co-60 dose by a factor of 4 is of great consequence in terms of occupational exposure and exposure during transportation operations. The Pu risks will be around for hundreds of thousands of years and so a difference by a factor of 3 is very significant. The C-14 is considered by some experts as a principal environment hazard of nuclear power operations yet

the estimates of C-14 differ by a factor of 1300!

As one of the scientists who has tried to make nuclear energy and its product nuclear power acceptably safe during the past 45 years, I feel a bit insulted by any organization that suggests uncertainties of the occupational and environmental radiation hazards of the above magnitude should be acceptable.

4. Both the Licensee and the NRC Have Left a Record That Cast Doubt on Their Sincerity when They State They Give High Priority to Safety and Conformance to ALARA.

The public record of the licensee is well established and need not be elaborated here.

The atitude of the NRC and its senior staff toward radiation safety is exemplified in a letter I wrote to the chairman of NRC (see Appendix A) which, by the way, was never answered. To me it is incredible that an organization such as the NRC claims its policy is to conform with ALARA while at the same time it blindly accepts recommendations of ICRP to increase levels of maximum permissible air concentration (MPC)a of radionuclides such as H-3 by a factor of 4.4, 20 for C-14, 1.5 for Co-60, 1.4 for 1.7×10^7y I-129, 2.1 for I-131 5.4 for Cs-137, 2.7 for Pu-239, etc and increases values in water (MPC)w such as H-3 by a factor of 3, 2.0 for Co-60, 2.0 for I-129, 1.7 for I-131, 2.0 for Pu-239, etc. (see Appendix B, Table 3)

Also, I consider it incongruous that the NRC like the ICRP, has not lowered the level of maixumum permissible exposure to external sources of ionizing radiation, MPE by at least a factor of 3. The present MPE and values recommended in BEIR-III are based on the risk of radiation induced cancer as determined by studies

of survivors of the atomic bombings of Hiroshima and Nagasaki. Those doing these studies have recently published papers showing this risk is greater at least by a factor of 3 than previously published values. The British have lowered their MPE by a factor of 3 (see Appendix C) with indications additional reductions may follow. Why is the NRC stalling?

The table below gives values of radiation induced cancer.

Comparative Values of Cancer Risk

Source	Cancers/Person, rem by: Absolute Model	Relative Model
BEIR-1972	1.15×10^{-4}	5.68×10^{-4}
UNSCEAR-1977	$(0.75\text{-}1.75) \times 10^{-4}$	
ICRP-1977	$(1.0\text{-}1.25) \times 10^{-4}$	
NRC-1981	1.35×10^{-4}	5.4×10^{-4}
Recent Japan Studies-1988	$(4\text{-}8) \times 10^{-4}$	$(1.6\text{-}3.2) \times 10^{-3}$

5. The Licensee Does Not Propose the Use of the Most Recently Developed and Recommended Instrumentation and Environmental Monitoring Procedures in Order to Comply with ALARA.

A number of improvements in instrumentation, techniques and operating procedures are recommended in the Environmental Monitoring Report prepared by Dr. Ruth Patrick of the Philadelphia Academy of Natural Sciences, Prof. John Palms, Vice Pres. of Emory University, et al for the TMI Public Health Fund. Especially pertinent are some of sections in Appendix F of this TMI-PHF report (See Appendix D). It is unthinkable that the NRC has not considered monitoring of wells and springs. The reader is referred also to a paper by Prof. John M. Palms.[1]

6. The GPU Staff and the NRC Do Not Make it Clear Which Waste Water Will Be Treated or If Any Pretreatment is Now Planned.

There are many sources of contaminated water evolving from the TMI-2 cleanup. Because of uncertainties and risk of mistakes, I believe these water sources (other than the sanitary sewer) should not be separated and treated differently – they should all be treated by the SDS and EPICOR-II system; each of course with the necessary preparitory treatment.

In some responses it is stated the water will be treated by both the SDS and EPICOR-II systems (e.g. NRC Staff Response dated Feb. 22, 1988, page 4) In other responses, however just the contrary is stated (e.g. GPU ID 0068P, Feb. 3, 1987, page 1). What are we to believe? I believe the problem of uncertainty in concentration of the various radionuclides is not with the analysees in most cases but with the extremely poor and definately unacceptalbe method employed by the licensee in providing representative water samples.

7. The NRC Staff Demonstrates a Warped or Seriously Distorted Understanding of the Risk from the Transuranic Radionuclides.

Page 7 of the NRC Staff Response to Interrogatories from TMI/SVA of Feb. 22, 1988 states, "However from the results of the analysis of PWST-2 (see response 2 above) transuranics make up less than 1% of the total curie content of AGW as they do in Table 2.2 of Supplement No. 2 as well."

NRC Staff would console us about their lack of serious consideration of the transuranics in the AGW because on a curie or activity basis they comprise less than 1%. To me this is absurd. Essentially all the curies in Table 2.2 (i.e. 1020/1021.2 or 99.88%) consist of H-3. However the relative cancer risk of Pu-239 to that of H-3 as given by the ratio of the inverses of (MPC)a for the two radionuclides is $5 \times 10^{-6} / 2 \times 10^{-12} = 2{,}500{,}000$. In other words one would want the content (curies) of the transuranics to be 0.00004% rather than 1% for the risks to be comparable. Furthermore, there are many publications showing the (MPC)a for Pu-239 is far to large.

8. The Licensee and NRC Appear Not to Be Giving Serious Consideration to the Modifications I Have Suggested to the Vaporation Method.

   See Recommendations dated March 19, 1987 and March 2, 1988.

9. The EIS Fails to Comply with Requirements of the NEPA (see SVA/TMIA's Response June 20, 1988)

10. There Has Not Been Provided Convincing Evidence That the Evaporator Method as Proposed Will Provide an Overall Decontamination Factor of 1000.

    Problems associated with liquid transfer, spillage, accidents, shut-down, equipment failure, sabotage, explosion, reduced efficiency, etc. have not been given thorough consideration.

11. The Need for a Biological Effectiveness Factor Greater Than 1 for Low Energy Beta Radiation Has Not Been Recognized. Toward the end of their tracks electrons or beta particles have a very high specific ionization or stopping power, dE/dx, and thus approach alpha and fast neutron particle values of RBE. The ICRP now sets the RBE of alpha and fast neutrons at 20. Many studies indicate the RBE for low energy beta radiation such as that from H-3 and C-14 is greater than 1 and may be as high as 5. In other words, this factor alone would indicate an underestimate of the population dose and the concomitant risks of radiation induced malignancies and genetic defects by a facotr as much as 5.

12. It Is Unrealistic to Assume That C-14, I-129 and Cs-137 Will Be Removed Completely by the Proposed Evaporation System.

    This must be proven by experiments which have never been done and one must not rely on theory.

13. The Evaporation System of 1/5 gal/min Would Take 319 Days of Continuous Operation with No Shut Down and Perfect Operation.

    This is too long to hold a tiger by the tail! Actually the operation probably would take over 2 years under the most favorable circumstances. With the modifications I have suggested, it would take much longer.

14. Neither the Licensee Nor the NRC Seem to Know What the

Natural Background Radiation is in the Local Area.

The Licensee gives the background as 300 mrem/year and the NRC gives it as 178 mrem/year. This is the starting point in determining the added radiation risk and accurate values must be provided area-wide for this.

This information is essential for those writing the last chapter and the conclusion of Who Done It!

15. The Licensee and the NRC Have Consistantly Underestimated Both the Occupational and Public Radiation Dose and Risk of Radiation Induced Malignancies and of Genetic Defects.

See my comments dated March 19, 1987 and March 1988 and Appendices B and C.

It should be appreciated that since both H-3 and C-14 deposit in the gonad and in DNA and RNA, they are a genetic risk to children yet to be born a thousand years from now. Because of the reactions $^{3}H \rightarrow \beta + {}^{3}He$ and $^{14}C \rightarrow \beta + {}^{14}N$, one of the 46 chromosomes in a germ cell of a homo sapien can end up suddenly with a hydrogen atom replaced by a helium atom of gas or a carbon atom may be replaced by a nitrogen atom.

B. Present Opinion Regarding Disposal of Contaminated Water at TMI-2

Because of the above and other facts I have concluded that all plans for the evaporation procedure should be abandoned. I believe, as indicated above, that all the contaminated water should be treated by the SDS and EPICOR-II Systems following appropriate pretreatment. The solid or slurry residue from these treatments should be sized, mixed with

cement in 55 gal. drums and sent to a licensed burial ground, e.g. Hanford. The contaminated water should be placed temporarily in large holding tanks. Other pretreatments, ion exchange chemical steps and better systems that are effective in removing stable boron and more of the radionuclides should be investigated and applied where feasible.

The holding tanks should be so installed and located that any leakage is known with absolute certainty to drain into a sampling sump tank. Great care must be taken to prevent any explosive materials entering the tanks via sabotage or otherwise. Under no conditions should cement, solidifying or coagulating materials be placed in these tanks. It is likely plans will be undertaken to remove this contaminated water at a later date and we do not wish to be confronted then with problems such as those that stalled and daunted operations at West Valley.

C. Recommended Future Course of Action

Ultimately, it will be desirable to drain the tanks of the 2.1×10^6 plus gallons of contaminated water. Most of the activity (curies) in the tanks will be that of H-3. Various estimates of the H-3 activity are provided us but if the initial level is 1000 Ci, the drop off in time of H_3, Cs-137, Sr-90 and Pu-239 will be as follows,

Time(y)	H-3 Ci	Cs-137Ci	Sr-90Ci	Pu-239μ Ci
0	1000	0.03	0.08	300
1	945	0.029	0.078	300
10	568	0.028	0.062	300
30	184	0.015	0.038	300
50	59	0.009	0.023	300
100	3.5	0.003	0.007	299
200	0.012	0.0003	0.0005	298 (0.000298 Ci)
300	0.00004	0.00005	0.00004	297 (0.000297 Ci)
20,000	~ 0	~ 0	~ 0	169
100,000	~0	~0	~ 0	18

Since most of the initial activity is that of H-3 (HL=12.262 y), the above column 2 represents the total activity in the tanks as well as that of H-3 until about 300 years when the CS-137, Sr-90 and H-3 activities are all about equal. After 200 years the Pu-239 activity is about equal to that of Cs-137 and Sr-90. The Pu-239 activity predominates and is significant after 20,000 years when it consists of 127,000 maxiumu permissible body burdens for a member of the public (i.e. 0.0013 μ Ci).

Many factors and circumstances will determine how long the contaminated water should remain in the tanks. It would seem to me, however, 30 years might be reasonable. With proper adjustment of ph the tanks should not leak in this time while the activity of H-3 will have dropped to 18.4% and that of Cs-137 and Sr-90 to about 50%. If over this time a 5000 gal. tank gave indication of leakage its contents could be mixed with concrete as it is emptied into about 100 55 gal. drums and then shipped to a state operated medium level repository.

D. Concluding Comment

I appreciate very much the value of having an Atomic Safety and Licensing Board, ASLB, and for several years I served on a NRC committee to recommend memberships on these ASLB's. For the most part I believe members of these Boards strive to be impartial but in many cases they have a conflict of interest and I believe the selection process should be modified to minimize this conflict. It would seem that membership on these Boards should reflect as equally as possible the views and goals of the public living near the nuclear power plant as well as views of the nuclear utility. I am not convinced that this is always the case.

On another point, I believe the method of financing the ASLB hearings should be improved. Members of ASLB and their consultants and the NRC staff are paid by the NRC and there should be some arrangement by which members of the public and their organizations that contest plans of the utility that affect them can be paid a fee and have coverage of their expenses. Some years ago (just a few days before I had to rush home to testify before Senator Kennedy in a Congressional hearing regarding consequences of the TMI-2 accident) I testified in the Gorlieben Hearings against a proposed method of the West Germans to dispose of radioactive waste in dome salt. It was my impression that both sides of this controversay were financed by the W. German government. Why can't we in the U.S. be as democratic as the W. Germans? Because I know we have no such system in the U.S. and some members and organizations of the local community are striving so nobly for their Constitutional rights I have not asked to be paid and will not request payment for many days I have spent in preparation for these hearings; this in spite of the fact my sole business and livelihood is that of consulting in health physics and defending in our courts plaintiffs who have evidence of injury from excessive exposure to ionizing radiation.

This is not a criticism of the present ASLB but a plea that the NRC will try to make this process more democratic and fair to the heroic members of the public that try to make this democratic process a useful and successful operation even though most of those in this community and in other communities where I have intervened relative to nuclear utility proposals believe there is much room for improvement of this process.

Reference: John M. Palms, B.G. Wahlig, D.M. Walker, M.R. Ghave,

"Problems Associated with Routine In-Plant Radioactive Effluent Monitoring Systems at U.S. Light-Water Reactors." Accepted for publication in "Nuclear Safety."

Respectfully Submitted

Karl Z Morgan

Karl Z Morgan

APPENDIX A

1984 Castleway Drive
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May 4, 1988

Mr. Lando W. Zech, Jr., Chairman
U.S. Nuclear Regulatory Commission
1 White Flint North
11155 Rockville Pike
Rockville, MD 20802

Dear Mr. Zech:

During the period of April 10-19, 1988 I attended meetings in Sydney, Australia of three organizations, the International Radiation Protection Association (IRPA), the International Commission on Radiological Protection (ICRP) and the International Atomic Energy Agency (IAEA). At these meetings Mr. R. E. Alexander of your organization gave a paper with which I strongly disagree. The principal focus of his paper was that he and his staff were recommending to you that the NRC not follow the lead of the UK by reducing the maximum permissible exposure (MPE) for occupational workers by 1/3, i.e. from 5 rem/y to 1.5 rem/y. He proposed that the NRC mimic the ICRP and count more bodies before reducing the MPE.

I was one of the 13 members of ICRP for over 20 years and now am one of its 4 emeritus members but have been strongly in opposition to two of its recent moves: 1) to increase levels of maximum permissible concentration (MPC) of radionuclides in air, water and food at a time when the changes should have been in the opposite direction because the risk of radiation induced carcinoma is now known to be much greater than we thought it to be when ICRP-2 was published in 1959 and 2) at its 1987 meeting in Como, Italy ICRP acknowledged that its estimate of risk of radiation induced fatal cancer, $\sigma = 1.25$ per 10,000 person·rem, was too low in light of recent publications of the RERF Japanese research group doing studies on survivors of the atomic bombings of Hiroshima and Nagasaki but failed to act.

As you know, the recommended values of MPE as given by ICRP and applied by the NRC are based on values of σ as determined by the Japanese studies.

Prior to the Como meeting of ICRP a petition signed by over 800 scientists (including myself) from 16 countries requested the ICRP to reduce the MPE level. In response the ICRP acknowledged that "Under the new DS-86 dosimetry this increase in risk is reported as being by a factor of about 1.4" and that longer follow-up "and other factors cited in the paper (D.L. Preston and D.A. Pierce of RERF) raise the risk estimate for the exposed population by a further factor of the order of 2." The product of these two factors is about 3. To me it was incredible and amazing that in spite of this recognition of fact the ICRP concluded, "This information alone is not sufficient to warrant an immediate change in the dose limits."

Fortunately for the workers in the UK the National Radiological Protection Board took appropriate action to protect its radiation workers in November 1987 (NRPB-GS9) and ruled "Consequently, the Board recommends that the occupational

workers exposure should be so controlled as not to exceed an average effective dose equivalent of 15 mSv per year (1.5 rem/y)." This reduction by a factor of 3 has been taken as an initial step with the understanding that additional reductions probably will be required when the reevaluation of the Japaneses data is completed. The need for an additional reduction seems eminent because Preston and Pierce using a linear dose-effect model arrive at a radiation cancer risk of $\sigma = 16$ fatal cancers per 10,000 person.rem or $(1.25/16) \times 5$ rem/y = 0.39 rem/y or a reduction by a factor of 12.8 instead of a factor of 3.

Regarding the first move of ICRP to which I have objected (mentioned above), I enclose a copy of a table which I gave in a lecture in London last year and which was published in the book Radiation and Health by Jones and Southwood, John Wiley & Sons. This table emphasizes the appalling fact that when ICRP published ICRP-26 (1977) and ICRP-30 (1979) it increased rather than decreased the MPC values for a number of the radionuclides of major concern to the NRC such as Sr-90, C-14, Co-60, I-131 and Pu-239. I was chairman of the original Internal Dose Committees of both ICRP and NCRP for over 20 years and this was during the time when ICRP-2 was published. This ICRP-2 is the basis of NRC limits set in its former Title 10 Part 20 regulations which were in use by the NRC for over two decades. I testified before the ACRS in opposition to the NRC moving in the wrong direction and using the ICRP as a template in revising its values of MPC and was under the impression that Mr. Alexander sided with me on this issue, but apparently I was mistaken--politics and appeasement of those in the nuclear industry rather than a lower cancer risk are more important. Incidentally, as one of the five first health physicists (there are 20,000 in the world today), as the director of the Health Physics Division of ORNL for 29 years and as the first president of both the Health Physics Society and the IRPA, I still am in favor of the proper use and development of nuclear energy but not at any cost. I applauded the NRC when it set the value of 1 rem at $1,000 or the value of a human life at $10,000,000 (i.e. $1,000 ÷ 1 fatal cancers per 10,000 person.rem = $10,000,000 per fatal cancer). Now, however, with $\sigma = 10^{-3}$, $1,000 per person rem corresponds to only $1,000,000 per human life. Is this an appropriate evaluation? I believe we could have this industry without coverups and half truths; I believe that some of the nuclear power plants have an excellent operating record and should be commended and encouraged to further improvements while others have a miserable record of safety and acceptable operational history and should have been shut down and decommissioned permanently. I hope in the years to come a major portion of the interest and effort of NRC will be in the development of inherently safe nuclear power plants--only then will we have no more Chernobyls and can we expect more orders in the US for new nuclear power plants. Many persons balk at the nuclear waste problem and believe it is insoluble but as the director of the ORNL-HP division that conducted the studies on disposal of high level nuclear waste in the Kansas bedded salt formations, I believe this problem can be solved but only by a hard-nose policy and programs and not by depreciating the risk of radiation induced cancer and failure to acknowledge facts. Since I left ORNL in 1972, the radiation waste disposal program has languished and is trying to reinvent the wheel.

There are many reasons why the cancer risk is greater than that given in BEIR-III & IV. I enclose also a few additional pages from the above references.

In this I give some of these reasons. Also, we must recognize as concluded by an expert committee of the GAO (Report to the Congress of the United States, Problems in Assessing the Cancer Risks of Low-Level Ionizing Radiation Exposure Vol. 2, EMD-81-1, Jan, 2, 1982) that at low doses the supra linear relationship fits the data better than the linear function and for this reason alone we should be cautious in avoiding all unnecessary exposure and follow the ALARA principle. The weak arguments given by Mr. Alexander for not reducing the MPE are available to you so I do not enumerate them here. They wane into insignificance in relation to these other facts, some of thich I have provided you.

I have testified in the House and the Senate many times and when the issue came up of uranium miners working at Rn-222 levels equal to and higher than those in the cobalt mines of Schneeberg and Saxony and Joachimsthal of Bohemia in 1500, I did what I could to reduce these exposure levels but it was like hollering in the wind. I was frustrated when the USPHS and the FRC sided with the AEC and they offered congressional testimony to try to negate that which I offered. I had been naive in believing the USPH Service was operated to protect the health of people in the U.S. I was not surprised that the AEC sided with industry. However, I rejoiced in that an honest man finally turned up in Washington. Mr. Wirtz, Secretary of Labor, came to the rescue of the dying uranium miners. Following my testimony before the Department of Labor he unilaterally reduced the level I had recommended to 4 WLM/y ($\sim 3 \times 10^{-8}$ μCi/cc of Rn-222). I often wonder how Democracy survives in a society where money and social and political stature are all important but now I know. It takes only one honest man under the right circumstances to make Democracy work. I hope and pray in this instance I am not disappointed

In conclusion I will be most grateful if you provide the other Commission members with a copy of this letter. There will be no need to have Mr. Alexander respond to this letter because I have already heard him expound his views on this subject. Also, I wish in no wise to deride or berate him; everyone should have a right to express his views and establish his position on an issue of public concern. In this case, of course, you are the one to evaluate these opinions and make the decision. I trust it will be in favor of the radiation workers.

Respectfully submitted.

Sincerely,

Karl Z. Morgan

Karl Z. Morgan

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Enclosures

Pages: 33
Accession Number: 8610200228