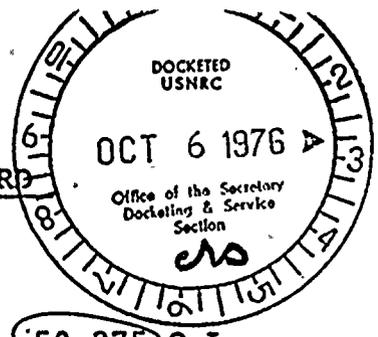


UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD



9-20-76

In the Matter of)
PACIFIC GAS AND ELECTRIC COMPANY)
(Diablo Canyon Nuclear Power Plant,)
Units Nos: 1 and 2))

Docket Nos. (50-275) O.L.
50-323 O.L.

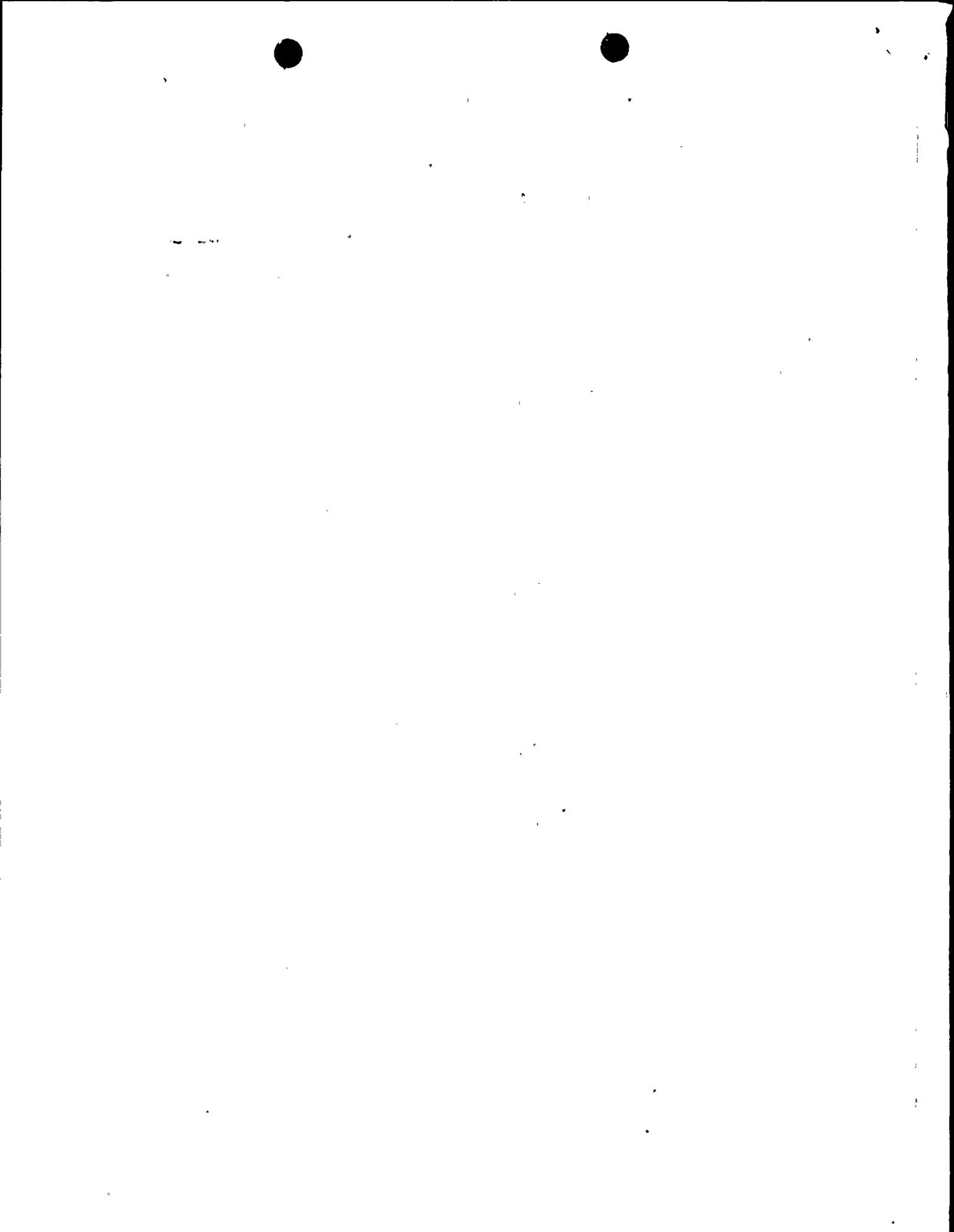
AFFIDAVIT OF ROLAND FINSTON

Roland A. Finston deposes and says under oath as follows:

1. I am a health physicist and am employed at Stanford University, Stanford, California as Acting Director of the Health Physics, Safety and Health office and as a lecturer in Nuclear Medicine.

2. My professional qualifications include a Bachelor of Science in Physics from the University of Chicago in 1957; a Master of Science in Health Physics from Vanderbilt University and Oak Ridge National Laboratory in 1959; and a Doctor of Philosophy in Biophysics from Cornell University in 1965. I was an Associate Professor of Radiological Physics at Oregon State University in 1965-66, and I have been employed at Stanford University since 1966 as a health physicist. I have specialized in medical health physics and in this specialty have taught radionuclide dosimetry and have also been responsible for calculating the radiation dose to patients which results from

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purposely administered radiopharmaceuticals. I am a member of the University's Human Use Radioisotope Committee which is also approved by the FDA as a Radioactive Drug Research Committee.

3. I wish to present to the Board information which is relevant to Contentions 4A through 4D, inclusive, of the Board's Order of September 1, 1976, which outlines the contentions which will be considered at the upcoming environmental hearings. The purpose of my affidavit is to assess the analysis and conclusions presented by the NRC Staff's Motion for Summary Disposition of Contentions 4A through 4D and the accompanying affidavits of Marvin Goldman and Michael Parsont, in order to indicate that there is a genuine issue of fact which mitigates in favor of a denial of the Staff's Motion for Summary Disposition. I have reviewed that motion and the accompanying affidavits, as well as information recieved subsequent to the filing of the Motion (received by Counsel for the Intervenors by telephone on September 17, 1976, from Dale Ketchum), as well as the FES, Addendum, and agency comments to the original FES. I am familiar with Appendix I to 10 CRF Part 50.

4. My affidavit will show that the Staff analysis, including the affidavits accompanying the Motion for Summary Disposition, has not included an adequate assessment of the environmental costs, doses and effects of low level radiation as to (a) the build-up of concentration of radioisotopes in the food chain; (b) the number of nuclear reactors planned for the state; (c) the somatic effects, including incidences of human



cancers, leukemias, and infant mortalities and genetic effects of routine releases on the population within a 50 mile radius of the plant; and (d) the somatic and genetic effects on plant personnel including inadvertent ingestion of radioactive materials. The evaluation of the Staff analysis for each contention will be taken in turn.

Contention 4A -- Build-Up of Radioisotopes in the Food Chain.

5. The only meaningful data provided to me by the Staff are "bottom line" computations by the Staff on the Appendix I low level radiation doses expected for the Diablo Canyon Nuclear Generating Station (DCNGS). These were provided to counsel for the intervenors by telephone, and were computations arrived at and reported on in the forthcoming Appendix I testimony. It is impossible to evaluate the correctness of these figures without access to the underlying calculations. Inasmuch as the NRC Staff has not yet transmitted a copy of the Appendix I testimony to the Intervenor, I reserve comment upon the adequacy of the FES as to its evaluation of low level radiation doses on the concentration of radioisotopes in the food chain. It is possible, however, that the low level emissions of radioactivity within a 50 mile radius of the DCNGS, considering all food chain pathways, are below the allowable Appendix I levels. I agree with the comments provided by the Department of Health Education and Welfare (FES, p. A14-1-17) and by the Environmental Protection Agency (FES, p. A14-1-31) that the FES may have ignored the possibility that the effect of Iodine-131 releases on the



air-pasture-cow-milk-human-thyroid pathway could result in an emission in excess of the allowable 5 mrem/year for any such individual located beyond the plant property boundary and within the 50 mile radius which is the subject of this contention. Since the Appendix I calculations have apparently superseded the calculated doses contained in the FES, it will be necessary to evaluate the basis of those calculations in assessing the adequacy of the reaction to both agencies' comments.

Contention 4B -- Number of Nuclear Reactors Existing in or Planned for the State

6. I am in agreement with the portion of Dr. Parsont's affidavit (Attachment 6 to the NRC Staff's Motion for Summary Disposition) which concludes that "[t]he environmental costs of the radiological dose contribution from existing California nuclear generating facilities is insignificant, based on the calculated doses presented previously." (1) However, this agreement is limited to the Contention as it presently is before the Board. Counsel for the Intervenors have petitioned for reconsideration to broaden the scope of this contention to "Number of nuclear reactors planned for this State." If the Board rules in the Intervenors' favor on the Petition, the effect of the low level emissions at DCNGS on other reactors, both existing and contemplated in California, should be calculated. It is impossible to know the effects that the DCNGS will have on reactors contemplated for California without knowing all of their exact locations and sizes, but extrapolating from the data prepared by the Staff for existing reactors, the effect that low level emissions from DCNGS will have on reactors located more than ninety miles from the site appears to be insignificant.



Contention 4C -- Somatic and genetic effects on Population within 50 miles

7. The NRC Staff analysis of the background radiation and corresponding rate of cancer deaths on the 260,000 person population living within a 50 mile radius of the DCNGS is incorrect. It was assumed (2) that the background radiation for the 260,000 person population was 30,000 man-rem/year. Data specific to the region (Santa Barbara being the closest area for which figures are available) indicate that the combined internal and external dose of radiation is 82 mrem/year. (3) This results in a corresponding background radiation of 21,000 man-rem/year ($82 \text{ mrem/year} \times 260,000 \text{ persons} = 21,000 \text{ man-rem/year}$). The effect of this lower background radiation figure is to make the relative impact of low level radiation from the DCNGS higher than that originally offered in the Goldman Affidavit. Accordingly, the PES should consider data which is more pertinent to the geographical area in which the reactor is located, and take into account the effect of the DCNGS on a reduced background radiation rate.

8. The National Academy of Sciences (BEIR) report of 1972 actual estimate of the most likely rate of cancer deaths was 152-204 deaths/million man-rem, and not 89, as is stated in the Goldman Affidavit at p. 3. (4) The NRC study relied on in the Goldman Affidavit only based its figure of 89 on the BEIR Study; the available data should be considered rather than an extrapolation or interpretation of that data. Accordingly,



using the figures of 152-204 cancer deaths/million man-rem due to low level emissions from the DCNGS, together with the doses computed for Diablo Canyon effluents (3.7 man rem/year), the risk is increased by a factor of at least 2 from that reported in the Goldman Affidavit. (3.7 man rem/year X 152 to 204 cancer deaths/million man rem = 6.6×10^{-4} risk, double the figure of 3.3×10^{-4} given at p. 4 in the Goldman Affidavit). The risk factor of 6.6×10^{-4} (as properly calculated, using correct BEIR data) is not conservative, as the Goldman Affidavit notes, p. 4, but in fact is recognized as the best estimate currently available. In fact, the BEIR best estimate of the number of cancer deaths per million man-rem may be non-conservative by a factor of 2, if the relative risk model applies. That model would predict twice as many cancers to occur from a given dose than does the absolute model. The effect of "conservatizing" the BEIR data is to further increase the risk factor of 6.6×10^{-4} by a factor of 2, i.e. to 1.3×10^{-3} .

Moreover, the conclusion that radiation absorbed at millirem per day levels is one-fifth as damaging as when absorbed at rem per day levels is considered by the EPA to be not a prudent choice for central risk estimates.(5) The basis for the conclusion in the Goldman Affidavit that the risk of radiation at low level emission rates is proportionately less than at higher, i.e. rem per day, levels (2) is the conclusion that "molecular repair and reconstitution of initial 'lesions' can take place... such that the yield of 'effects' per unit dose is lower than



when the dose or rate are high. . ." (Goldman Affidavit at 4). This conclusion is surprising, since the concept of reconstitution of radiation lesions in genetic cells at low doses and dose rates ascribed by Goldman to S. Abranamson is interpreted oppositely by the Environmental Protection Agency (6). That report indicates that in mouse oögonia, the reduced genetic effects observed are due to cell death rather than to cellular repair mechanisms. In other words, fewer cells indicate genetic mutation at low levels of radiation, because those cells which would contribute to genetic mutation do not survive. This conclusion in no way indicates that low level emissions are somehow "less damaging" than high levels, an indication which is relied upon in the Goldman Affidavit. It is improper, therefore, to reduce a risk factor by five simply because the source is a low-level emitting source. The EPA report would support the conclusion that the risk factor at low level emission rates is as great as at high level (i.e. rem per day) emission rates. Accordingly, the risk factor of 1.3×10^{-3} is the factor arrived at using conservative data. Although the radiation risk may still be negligible (i.e. 444 cancer deaths increased to 444.0013 deaths due to operation of the DCNGS), the effect of this increased risk factor, when combined with emissions from other sources (accidents, waste, transportation) should be considered in the FES.

Contention 4D -- Somatic and Genetic Effects on Plant Personnel

9. The FES, Motion for Summary Disposition, and accompanying affidavits inadequately evaluate the impact of low



level radiation emissions as to the somatic and genetic effects on personnel working at the plant. It is not clear from the Staff's materials how the figure of 450 man rem per year per unit for occupational exposures of plant employees was computed. The correct figure is 1.3 man rem per Megawatt-year for occupational exposures of plant employees, which is the figure commonly used for the DCNGS reactors. (7) The gene pool dose contributed by workers at the station is therefore computed as follows:

$$\begin{array}{rclcl}
 2190 \text{ Megawatts} & \times & .85 & \times & 1.3 \text{ man rem/Megawatt year} = \\
 (\text{capacity of site}) & & (\text{DCNGS operation} & & \\
 & & \text{capacity}) & &
 \end{array}$$

2400 man-rem/year.

This is the annual dose contribution by DCNGS workers to the gene pool dose. It is important to compare the contribution of this dose to the natural background dose and to the other source of radiation, the genetically significant medical X-ray dose. As stated previously, the background dose for the 260,000 person population living within a 50 mile radius of the plant is 21,000 man rem per year. The addition of 2,400 man-rem/year to that background dose is genetically significant; in fact it represents more than a ten percent increase in the dose of radiation to the gene pool. The FES and documents reviewed subsequent to the publication of the FES have inadequately assessed the impact of a more than ten percent increase in the background radiation. Furthermore, the genetically significant medical X-ray dose to such a population (260,000 persons) is 5,200 man rems per year. (8) An impact of 2,400 man rem/year upon this genetically significant



medical X-ray dose to the indicated population represents almost a fifty percent increase in exposure. This increase is a significant environmental effect which the NRC Staff must consider before contending that the FES and Amendments are adequate.

10. The dose rate dependence of mutational effects of irradiation is the subject of active scientific debate. The estimates of rate dependence found in the BEIR Report (4) and relied upon by the Staff in its supporting documents for the Motion for Summary Disposition have been criticized by the Environmental Protection Agency as being perhaps 140 to 220 percent low. (6) Using this fact, and the fact that the 450 man rem/year/unit is low by a factor of five (see paragraph 9, above, which computes the occupational exposure at 2,400 man rem/year), the 20 genetic "effects" per generation at equilibrium calculated by Goldman (Affidavit at p. 7) may range from 100 to 300. That is, 20 genetic "effects" multiplied by the 5-fold increase in occupational radiation results in 100 genetic "effects", which may go as high as 300 genetic "effects" if the EPA analysis of the BEIR data is correct. Properly compared with the spontaneous incidence of 15,000 to 25,000 "effects" in a population of 1/4 million, or 260,000 (Goldman Affidavit at 7, 60,000 to 100,000 effects per million X 1/4), the increase in genetic disease is from 0.4% (100 effects/25,000 effects) to 2.0% (300 effects/15,000 effects). These genetic effects due to occupational exposure from the plant are certainly significant enough to merit evaluation in the FES by the Staff.



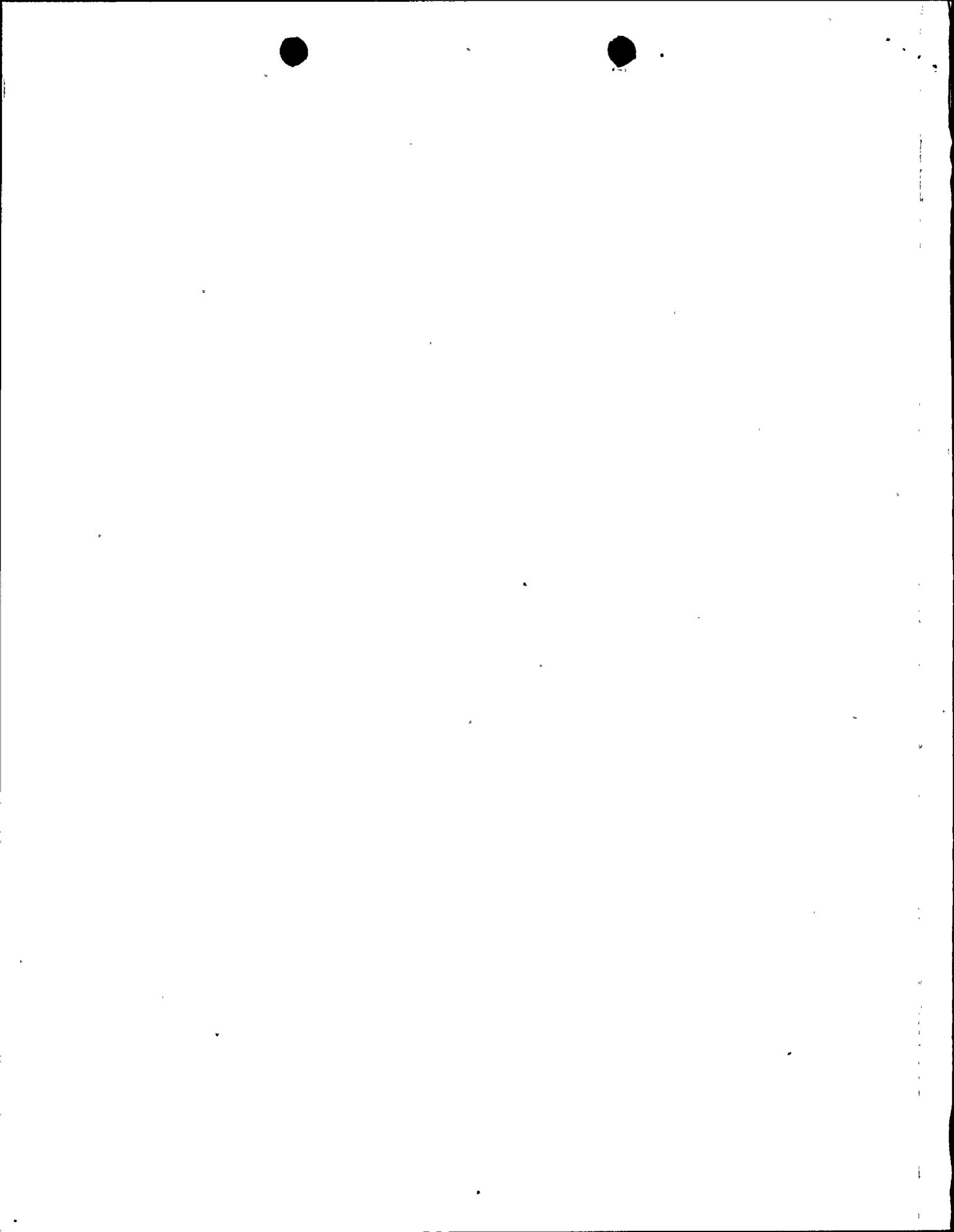
11. The genetic effect of low dose radiation on humans is less a matter of conjecture in light of recently published observations of the increased incidence of severe mental retardation in populations exposed to natural background radiation levels of 1.5 to 3 rems/year. (9) This rate is similar to that experienced by reactor workers, and therefore since the incidence of severe mental retardation may be indicated to a population so exposed, the effect is significant enough to be considered in the FES.

12. I must note that, because I was retained as a consultant for intervenors only recently, I have not had sufficient time to conduct a fully satisfactory technical review regarding these contentions. In the short time available to me, I was able to review the affidavits in support of the Staff Motion for Summary Disposition in order to evaluate some of the inadequacies in these documents and to identify errors in the Staff's own submissions. However, I had insufficient time to conduct a full literature search to find all documents and technical studies to support intervenors' contention that the Staff FES is inadequate. Also, I had insufficient time to consult with other health physicists working in the field regarding inadequacies in the Staff's environmental impact assessments. I would welcome the opportunity to be able to review the Appendix I data upon which Dr. Parsont relies for his conclusions regarding Contention 4A, and I would appreciate additional time in order to be able to assess the accuracy of the Staff's conclusion in the FES that the total body dose of low level radiation to the population living within 50 miles of the DCNGS is 3.7 man-rems/year.



References

1. Affidavit of Michael Parsont, Attachment 6 to NRC Staff's Motion for Summary Disposition, September 7, 1976, p. 7.
2. Affidavit of Marvin Goldman, Attachment 5 to NRC Staff's Motion for Summary Disposition, September 7, 1976, p. 4.
3. Oakley, D. T., Natural Radiation Exposure in the United States. U. S. Environmental Protection Agency, Office of Radiation Programs (ORP/SID 72-1), 1972, p. 36, 37, 50.
4. National Academy of Sciences/National Research Council, The Effects on Populations of Exposure to Low Levels of Ionizing Radiation ("BEIR" Report), NAS/NRC, Washington, D.C. 1972, p. 168-.
5. Reactor Safety Study (WASH 1400): A Review of the Final Report. U.S. Environmental Protection Agency, Office of Radiation Programs, June 1976, p. 2-5 to 2-8.
6. Ibid, at p. 2-11.
7. NRC, "Occupational Radiation Exposure at Light Water Cooled Power Reactors, 1969-1974, "NUREG-75-032, (June 1975) p. 7.
8. U. S. Department of HEW, Food and Drug Administration, Gonad Doses and Genetically Significant Dose from Diagnostic Radiology, U.S. 1964 and 1970. Publication FDA 76-8034, April 1976.
9. Kochupillai, N.; Verma, I.C.; Greual, M.S., and Ramalingsaswami, V., "Down's Syndrome and Related Abnormalities in an Area of High Background Radiation in Coastal Kerala", Nature 262, 60 (1976).



Subscribed and sworn to before me this 20th day of September, 1976.

Roland W. Finston

ROLAND FINSTON

STATE OF CALIFORNIA,

COUNTY OF Santa Clara

} ss.

ON September 20, 1976,
before me, the undersigned, a Notary Public in and for said State, personally appeared
Roland W. Finston

_____, known to me,
to be the person whose name _____ subscribed to the within Instrument,
and acknowledged to me that he executed the same.

WITNESS my hand and official seal.



DIANE MERWIN SMITH
NOTARY PUBLIC - CALIFORNIA
OFFICE IN
SANTA CLARA COUNTY

My Commission Expires November 6, 1977

Diane Merwin Smith
Notary Public in and for said State.

