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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
ARIZONA PUBLIC SERVICE COMPANY	)	Docket Nos. STN 50-528
	)	STN 50-529
(Palo Verde Nuclear Generating Station, Units 1, 2, and 3)	)	STN 50-530

SUPPLEMENTAL TESTIMONY OF NRC STAFF IN RESPONSE TO BOARD QUESTION 6

by

Ronald A. Zussman

This testimony is being offered in response to the part of Atomic Safety and Licensing Board Question 6 which relates to the airborne dispersal of pathogens. Question 6 reads as follows:

> Show each analytical step including assumptions and verification of claims utilized in staff's analysis to evaluate the public health and environmental impacts of the heat dissipation system relating to airborne dispersal of human pathogens, heavy metals, and pesticides.

In view of the applicant's proposal to utilize City of Phoenix treated sewage effluent as the sole source of Palo Verde Nuclear Generating Station (PVNGS) cooling water, the staff requested that additional information be supplied by the applicant concerning the survivorship of pathogens present in the water, so that any possible adverse impacts to the Public Health resulting from this use of the water could be evaluated. The language of the request was specific and detailed, and designed to elicit a response containing information sufficient

to serve as the basis of a staff evaluation and conclusion. In addition to the written request, scientific and technical aspects were informally discussed on several occasions.

On December 20, 1975, a draft study prepared for the applicant by Dr. Mark D. Sobsey was submitted to the staff for informal review.[1] The reviewers concluded that while the study was appropriately responsive and contained most of the needed information, one area of consideration required additional analysis - that of the interface between possible pathogens and a potential human host. The technical aspects of this conclusion were informally discussed with Dr. Sobsey, and it was agreed that the additional analysis would be provided in the formal issue of the document. The additional analysis was accomplished and the completed study was formally published in Supplement 3 to the ER.[2]

Diffuculties were encountered in evaluating the possible impacts of the use of treated sewage in the PVNGS cooling system. Virtually no studies are available concerning the dispersal of pathogens by cooling towers. While considerable work has undoubtedly been done by the military involving the aerosol delivery of pathogens ("germ warfare"), such information is classified. Finally, since the PVNGS cooling system is not in existence, but is yet a proposal, it was not possible to directly verify the applicant's performance claims by the gathering and analysis of actual data. For these reasons, the staff analysis and conclusions depended heavily on the scientific training, experience, and judgement of the staff. A number of technical assumptions were used in considering the applicant's analysis. All assumptions were conservative, where applicable. The assumptions were:

1. Any viable pathogens contained in Phoenix waste water could cause disease if dispersed to the atmosphere prior to inactivation.

2. No credit was given for self-purification of the effluent during pipeline transit to the PVNGS.

3. Fecal coliform microorganisms are generally appropriate as indicators of intestinal pathogens.

4. Fecal coliforms were considered to be at least as hearty as most pathogenic bacteria.

5. Viruses were assumed in general to be more resistant to treatment than bacteria.

6. The City of Phoenix sewage-treatment system was assumed to be an "average" system; that is to say: data obtained at other treatment plants could be validly applied to Phoenix.

7. From the standpoint of infectivity, the inactivation (destruction; killing) of pathogens is functionally equivalent to their removal from waste water.

8. Serial treatment steps were assumed to result in serial inactivation of pathogens. For example: if waste water containing 100 organisms per milliliter would be treated first by one method, and then by another, each of which

was known to cause a 90% reduction in infectivity, the remaining viable organisms would be 10% of 10% of 100, or 1 organism.

9. Where a number of values was available, only the most conservative value of the range of values was considered for the purpose of analysis.

10. Combined chlorine was assumed to be generally less biocidal than free chlorine; however, it was also assumed to be more persistent, thus capable of acting upon pathogens for longer periods of time.

11. Viruses and protozoan cysts were considered more resistant to chlorine treatment than bacteria.

12. Survivorship of residual microorganisms (after treatment) was considered to be inversely related to residence time prior to dispersal.

13. Survivorship was assumed to be inversely proportional to temperature and to roughly obey the $2Q = 10$ relationship where for each increase in temperature of 10°C, there would be a reduction in survivorship of about 50%.

14. It was assumed that only one inhaled pathogen would be necessary to initiate an infection-for many cases, this assumption is considered to be very conservative, since it is known that more often than not, hundreds to tens of thousands of viable, individual pathogenic entities are necessary to initiate an infection in a single host.

15. It was assumed that the most common route of inoculation of a hypothetical host in the vicinity of a cooling tower would be by inhalation. It was also assumed that in view of the tissue or organ specificity demonstrated by a number of enteropathogens, fewer infections could ever result than indicated by numbers of inhaled organisms, alone.

16. Because of the dispersion characteristics of cooling towers, it was assumed the risk of exposure would be less at areas distal to the tower compared to areas more proximal.

Working within the framework of the above assumptions, the staff's verification of the applicant's claims included the following activities:

1. Key references used by the applicant were checked.

2. Other references not cited in the applicant's study were consulted.

3. Calculations were checked. This activity resulted in the identification of an arithmetical error in Table 5 of the

applicant's study: in column "D" (drift conc., $1/m^3$), the value of 5.3×10^{-3} is erroneously given. The correct value is 5.3×10^{-4}. Since the correct value is actually smaller than the given value, the error was found to be in a conservative direction, and not damaging to the applicant's conclusions.*

4. Dr. Paul Adams, Director of the Army Environmental Sciences Division, Dugway, Utah was consulted. Dr. Adams, an acknowledged military expert in the field of biological warfare, discussed certain nonclassified aspects of atmospheric dispersion of microogranisms, as well as certain effects of the atmosphere (sunlight, dessication, etc.) on dispersed pathogens. Information gained through these discussions was applied to the staff analysis of the PVNGS cooling system.

On the basis of the above, the staff concluded that there would be no potential for public health impact due to the operation of the PVNGS cooling system.

*Subsequent to applicant and staff analysis, the applicant announced that the cooling tower drift rate would be reduced from 0.04% to 0.01%. Thus, values in Column "D" and those derived therefrom should be reduced by a factor of 4.

References

1. Letter and attachment from Lawrence T. Klein, NUS Corporation, to Ronald Zussman, ANL; dated Decmeber 20, 1974.

2. ER, S3-5.1-1.

PROFESSIONAL QUALIFICATIONS

Ronald A. Zussman
Argonne National Laboratory

My name is Ronald A. Zussman. I am on the staff of the Environmental Statement Project of Argonne National Laboratory. My principal responsibility is that of Project Leader in the preparation of Environmental Impact Statements. My title is that of Staff Biologist. In this capacity I also participate in the evaluation of biological environmental impacts of proposed nuclear power generating stations as assigned to me. Included in these responsibilities are considerations of disease and public health as related to nuclear power plant construction and operation. I also contribute to other environment-associated projects, both within my department and as a consultant. I am a member of the Laboratory's Bioconversion Committee. I joined the Environmental Statement Project in September 1972.

When schedules have allowed, I have also taught on a part-time basis at the graduate level in the Department of Biology, Roosevelt University, Chicago, Illinois.

I have a Bachelor of Science degree in Biology from Loyola University of Chicago, and a Master of Science degree and a Doctor of Philosophy degree in Microbiology from the University of Illinois at the Medical Center, Chicago.

From 1964 until 1972 I was employed in the Biological Sciences Division of Abbott Laboratories, Inc., North Chicago, Illinois. During this period I worked in both the Microbiology and Molecular Biology Departments. My principal assignments were in basic and applied research related to Biology, Invertebrate Pharmacology, Virology, Parasitology, Microbiology, and Immunochemistry. My major efforts in Invertebrate Pharmacology involved the study of the effects of biologically active agents upon Daphnia, Stylaria, Artemia,

Hydra, Planaria, and various Protozoans. My interests in Virology were focused principally upon Herpesvirus, Influenzavirus, and Bacteriophage. My studies in Microbiology, Parasitology, and Immunochemistry have been mostly oriented toward the medical and public health aspects of organisms which cause human and animal diseases.

From 1960 to 1963, while a graduate student, I also held the full-time position of Optical Instructor/Optical Supervisor at the Adler Planetarium and Astronomical Museum, Chicago.

From 1958 to 1963 I was a Teaching Assistant and a Research Assistant in the Department of Microbiology, University of Illinois College of Medicine, Chicago.

During my professional career, not including my Master's and Doctor's Theses, I have published approximately a dozen papers in learned journals such as the Journal of Bacteriology, Mycopathologia, Journal of Parasitology, Journal of Cell Biology, and Applied Microbiology. I have also published several articles on optical technology. I have presented papers before the American Society for Microbiology, the Chicago Medical Mycological Society, the American Society of Parasitologists, the Society of Sigma Xi, the Illinois Society of Microbiologists, and others. In 1969, I invented a scientific device, assigned to Abbott Laboratories, Inc.

I am a member of the International Association for Great Lakes Research, the American Society for Microbiology, the American Society of Parasitologists, the Chicago Medical Mycological Society, and the Society of the Sigma Xi.

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Station, Units 1, 2, and 3)	)	

SUPPLEMENTAL TESTIMONY OF NRC STAFF IN RESPONSE TO BOARD QUESTION 6

by

Fred Vaslow and Thomas W. Green

This testimony is being offered in response to Atomic Safety and Licensing Board Question 6 which reads as follows:

> Show each analytical step including assumptions and verification of claims utilized in staff's analysis to evaluate the public health and environmental impacts of the heat dissipation system relating to airborne dispersal of human pathogens, heavy metals, and pesticides.

In its evaluation of the dispersal of toxic elements (e.g., heavy metals) and pesticides by the Palo Verde heat dissipation system, the staff has primarily used calculations which were reported in applicant documents such as the Environmental Report and its supplements, and in NUS Document No. 1408.[1] These calculations evaluate both the amount of solids deposited on ground areas in a year's time from the cooling towers and the maximum and average concentrations of solids per unit air volume for different locations relative to the cooling towers. These calculations use the NUS Corporation's "Fog" computer program, which the staff considers to be at a reasonable state-of-art level.

In evaluating the ground depositions and air concentrations of toxic elements and pesticides, each material is considered as forming a given fraction of the total emitted solids. These materials then represent the same fraction of total solids deposited in any area or concentration in any volume of air. For example, the total solids emitted per year are about 1.3×10^7 pounds (ER Sec. 3.6.2), including 197 pounds of arsenic. Consequently, the ground deposition of arsenic or air concentration is $197/1.3 \times 10^7$ times that of total solids deposited such as are given as isopleths in Figure 3.6 or as air concentrations in Table 3.1. Air concentrations calculated in this manner are given in Columns 2 and 3 of Table 1 of this testimony and ground depositions for the worst case of 125 pounds per acre per year are shown in Column 4.

In Column 5 of Table 1 the staff has assumed conservatively that all substances deposited on the soil are not removed by organic decomposition, leaching, chemical inactivation etc., but rather are retained in the top 6 inches of

the soil during the lifetime of the plant. Even using these conservative assumptions, a total of less than 15 pounds of toxic elements and pesticides could be present on an acre at the end of plant lifetime. Many variables and processes such as chemical form of the element, present concentration in the soil, equilibrium point, bulk density, soil pH, erosion, mineral uptake by vegetation, etc., are not known for the site. These processes singly or in combination will probably reduce the concentrations below those given in Column 5 of Table 1.

To the staffs' knowledge, there are no data concerning the existing levels of the substances listed in Table 1 for the site area soils. It is therefore not possible to make a definite statement regarding the effects of adding the postulated concentrations (Table 1) to the existing background. However, cultivated crops have been grown and "typical" native vegetation has existed in the site area for many years. Thus, it can be assumed that the soils are not presently toxic to the species in question. The staff is of the opinion that the levels of toxic elements in the soil are unlikely to be so high (or close to threshold level) that the addition of the small amounts of material in question would create a condition toxic to vegetation or food chains.

To illustrate the above, fluoride comprises over half (by weight) of the toxic material listed in Table 1. The existing fluoride concentrations in the region, as inferred by the groundwater concentrations at the site (2.0-15.2 ppm), are relatively high (ER, Table 2.5-5). This may be due to usage in the site area of artifical superphosphate fertilizers which may contain 10,000 or more ppm fluoride and/or natural mineral consitutuents of the soil. The maximum probable increase in fluoride concentration in the soil after 30 years of PVNGS operation, assuming no leaching, is less than 5 ppm.

Biocides

The staff assumes that the maximum figure of 0.01 pounds of pesticides deposited on an acre of land over the 40 year period of the plant license (assuming no decomposition, conversion etc.) is negligible compared to the 15 to 35 pounds per acre per year presently being applied to cotton crops in the Buckeye area (ER, SI, Sec. 3.6).

Reference

1. Predicted 24-hourly concentrations of airborne salt particles from drift for the Palo Verde East Site using onsite meteorological data. Prepared for APS and ANPP by G. Fisher and L. Breitstein, June 1975. NUS Corporation Document No. 1408, Rockville, Maryland.

Table 1. Particulate Concentrations from PVNGS Mechanical Draft Cooling Towers[1]

Substance	1 Hour Maximum Site Boundary $\mu g/m^3$ air	24 Hour Maximum Site Boundary $\mu g/m^3$ air	Maximum Deposition Pounds/acre/year	Maximum Deposition Pound/acre Total for Plant Lifetime[2]
As	0.01	0.002	0.002	0.08
Ba	0.03	0.004	0.005	0.2
B	0.18	0.02	0.03	1.2
Cd	0.008	0.001	0.001	0.04
Cr	0.002	3×10^{-4}	5×10^{-4}	0.02
Cu	0.03	0.004	0.005	0.2
F	0.76	0.09	0.2	8.0
Fe	0.08	0.01	0.02	0.8
Pb	0.008	0.001	0.001	0.04
Mn	0.008	0.001	0.001	0.04
Hg	3×10^{-4}	4×10^{-5}	5×10^{-5}	0.002
Se	0.003	5×10^{-4}	5×10^{-4}	0.02
Ag	0.01	0.001	0.002	0.08
Zn	0.02	0.003	0.005	0.2
Pesticides	0.001	1×10^{-4}	2.5×10^{-4}	0.01

[1]Adapted from Tables 3.5 and 5.1 of the FES.

[2]Based on a 40 year period for the plant license with no removal by natural forces (i.e., leaching, decomposition etc.)

[3]Pesticides consist of chlorinated hydrocarbons with approximately 3% of organic phosphates.

Professional Qualifications

Fred Vaslow

Argonne National Laboratory

I am an environmental scientist in the Argonne National Laboratory Environmental Statement Project. I am responsible for reviewing and evaluating environmental reports submitted in application for the construction of nuclear electric power stations. My fields of review are in thermal and chemical impacts and in general fields.

I received my B.S. and Ph.D. degrees in 1940 and 1948 respectively from the University of Chicago. The fields were in Chemistry and Physical Chemistry with minors in Mathematics and Physics. Subsequently I have audited various courses in Mathematics and Chemical Physics.

In 1972 and 1973 I attended a school at the Oak Ridge National Laboratory for the writing of environmental impact statements. The courses were in Economics, Ecology, Meteorology, Hydrology and Environmental Heat Transfer, and a course in the Sources, Usages and Problems of Energy.

From 1942 to 1945 I worked on various phases of the wartime Manhattan (Atomic Bomb) Project. Locations where I worked were the University of Chicago, Iowa State College and the Los Alamos Laboratory.

In 1945 I returned to the University of Chicago and then went to the Oak Ridge National Laboratory where I finished my Ph.D. thesis research in 1948. The work was on the Thermodynamics of Coprecipitation. From 1948 to 1952 I was in the biology division of the Oak Ridge National Laboratory working on the Physical Chemistry of Enzyme Processes. The work on coprecipitation and enzymes involved extensive experience with nuclear reactors in the preparation of the radioisotopes used in both parts of the work.

From 1952 to 1956 I continued the enzyme work at the Carlsberg Laboratory in Copenhagen, Denmark supported by an N.I.H. fellowship and a grant from the Danish Academy of Sciences.

In 1956 to 1957 I spent a year at the University of Minnesota on a post-doctoral fellowship studying the physical chemistry of proteins.

From 1957 to 1973 I was at the Oak Ridge National Laboratory. The work was on the thermodynamic properties of ion exchangers and polyelectrolytes and on water and solutions of electrolytes. Extensive measurements of heat quantities and heat transfer (i.e. calorimetry) were made in this work.

In 1972 and 1973 as a full-time employee and as a consultant I was on the Oak Ridge National Laboratory Environmental Impact Project. My field of specialization was in thermal hydraulics where I evaluated thermal plume and developed a model for drift deposition from cooling towers.

I have 28 publications including a patent and a book chapter on the "Thermodynamics of Electrolyte Solutions."

I am a member of the American Chemical Society and the A.A.A.S. As a hobby I have walked extensively in environmentally sensitive areas such as mountain and low arctic areas of North America and Europe.

PROFESSIONAL QUALIFICATIONS

Thomas W. Green

Argonne National Laboratory

I, Thomas W. Green, am an assistant ecologist in the Environmental Statement Project at Argonne National Laboratory. My present duties include the analysis of Environmental Reports and the preparation of Environmental Impact Statements.

I have a Bachelor of Science degree in Wildlife Conservation (1968), a Bachelor of Arts degree in Zoology (1968) and a Master of Arts degree in Biology (1970) from California State University-Humboldt. I also have a Doctor of Philosophy degree in Plant Ecology (1973) from Utah State University.

My career has been mainly as a student in various areas of Biology-Ecology. I have taught (singley or team) several courses in biology and ecology in addition to a course in man and the environment. In 1971 and 1972 I served as Vice-President of the Cache Council for Environmental Quality and participated in the Speakers Bureau of that organization. From August 1973 to July 1974 I held a post-doctoral fellowship at the University of Houston where I was interim associate director of the Coastal Research Center. This position included part time work with local high schools and junior colleges on the impact of man on the gulf-coast environment.

My research has been in the areas of physiological reaction to stress environments (1966-1968), plant allelopathy (1968-1970), the effect of insect seed predators on the evolution and dynamics of plant populations

(1970-1974). At the present time I have 2 publications in print, 1 in press and 2 in review, all of which deal with the plant-herbivore interface. I have presented 4 papers at national meetings in the last 3 years.

I am presently a member of the Ecological Society of America, American Botanical Society, American Association for the Advancement of Science, American Institute of Biological Sciences, Society for the Study of Evolution, Society of the Sigma Xi, American Midland Naturalists. Several of these memberships are held jointly with my wife. I have also held membership in The Wildlife Society, American Society of Mammalogists, and the Scientists Institute for Public Information (Environment).

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ARIZONA PUBLIC SERVICE	)	STN 50-529
COMPANY, et al.	)	STN 50-530
	)	
(Palo Verde Nuclear Generating	)	
Station, Units 1, 2 and 3)	)	

SUPPLEMENTAL TESTIMONY OF NRC STAFF IN RESPONSE TO BOARD QUESTIONS 9 AND 11

by

MICHAEL A. PARSONT

This testimony is offered in response to Questions 9 and 11 posed by the Atomic Safety and Licensing Board. These questions read as follows:

> 9. Predict the amounts of I-131 which are likely to be released from the heat dissipation system, using the most recent available data on the City of Phoenix sewage.
>
> 11. Provide the projected radioactive effluent releases and calculated doses expected from PVNGS based on the model appropriate for new Appendix I of 10 CFR 50 as determined by the Staff.

I will first address Question 11 (as it relates to doses, the testimony of Mr. Bellamy addresses the projected releases from the facility).

Question 11 is directed to the NRC Staff's assessment of individual doses from expected routine releases of radioactivity deriving from operation of the Palo Verde Nuclear Generating Station (PVNGS). The Staff's assess-

ment was performed to determine if the PVNGS met the design objective doses contained in 10 CFR 50, Appendix I.[1]

In a letter dated September 26, 1975,[2] Arizona Public Service Company (the Applicant) indicated that it wished to exercise the option provided by the Nuclear Regulatory Commission's September 4, 1975 amendment (40 F.R. 40918) to Section II.D of Appendix I. The amendment provides that an applicant need not comply with the radwaste system cost-benefit analysis required by Section II.D of Appendix I if the proposed radwaste system satisfies the Guides on Design Objectives contained in the Concluding Statement of Position of the Regulatory Staff in Docket No. RM-50-2, dated February 20, 1974 (the RM-50-2 design objectives).[3] The Staff has, accordingly, undertaken to determine compliance with both the RM-50-2 and the Appendix I design objectives. These determinations involved different considerations, in that the RM-50-2 design objectives apply to all light-water-cooled reactors at a site, whereas the Appendix I design objectives apply to each reactor at a site.

The dose models used to perform both analyses are those set forth in Draft Regulatory Guide 1.AA.[4] These models were revised (with respect to the models contained in reference 3) to be responsive to the mandate contained in the Opinion of the Commission[5] relative to Appendix I, which called for realism, wherever possible, in the definition of input parameters for the dose models.

Included in this analysis are dose evaluations of two effluent categories: 1) noble gases released to the atmosphere and 2) pathways associated with radioiodines, particulates, carbon-14 and tritium released to the atmosphere.

The dose evaluation of noble gases released to the atmosphere included a calculation of beta and gamma air doses at the site boundary and total body and skin doses at the residence having the highest anticipated dose. The maximum site boundary air doses were at 1.2 miles E of the PVNGS. The maximum total body and skin doses were determined to be at a residence at the same location. Individual doses resulting from pathways associated with radioiodine, particulates, carbon-14 and tritium released to the atmosphere were evaluated. The maximum dose for this category was to the thyroid of a child (1-11 years old) whose diet partially consisted of 530 kg/yr of food crops produced at a residence 1.2 mi. E of the site, and who lived at this same residence for a full year. This dose was estimated to be 8.8 mrem/yr.

Because of a lack of additional information, it has been assumed that the annual intake of 530 kg of crops was produced at this same residence. This assumption will most likely cause an overestimation of the actual dose received by individuals living at this residence.

Dose estimates for the various pathways considered were made for adults (over 18 years of age), adolescents (12-18 years of age), children (1-11 years of age) and infants (less than 1 year old). Doses were calculated using parameters appropriate for each age group as discussed in Regulatory Guide 1.AA. The doses from noble gases released to the atmosphere constituted external exposure, and were, therefore, not age-dependent. As described above for the pathways associated with radioiodine and the other radionuclides released to the atmosphere, a child located 1.2 miles E from the site received the highest dose.

All of the doses in this analysis were based on the radionuclide releases presented in Mr. Bellamy's testimony. The dispersion of radionuclides in, and the deposition of radionuclides from, the atmosphere were based on an analysis performed by the NRC Staff.

As indicated earlier, a comparison with RM-50-2 design objectives involves all reactors at a site. Accordingly, using the procedure described above, a calculation was made to determine the doses associated with PVNGS operation. The results are shown in Table 1 and are compared with the RM-50-2 design objectives.

In order to make a comparison with Appendix I design objectives, a calculation similar to the one mentioned in the previous paragraph was performed. This computation was, however, directed at dose values for each reactor unit on the site. The results of the calculation are presented in Table 2.

Conclusion

It is concluded, based on the values presented in Table 1, that the aggregate doses associated with PVNGS operation meet the RM-50-2 design objectives.

It is also concluded, based on the values presented in Table 2, that the doses per reactor unit associated with PVNGS operation meet the 10 CFR 50, Appendix I design objectives.

Table 1

Comparison of Calculated Doses from
Palo Verde Nuclear Generating Station Operation
with Guides on Design Objectives
Proposed by the Staff on February 20, 1974[a]
(Doses to Maximum Individual from all Units on Site)

Criterion[b]	RM-50-2 Design Objective	Calculated Doses
Noble Gas Effluents		
Gamma dose in air	10 mrad/yr	2.2 mrad/yr
Beta dose in air	20 mrad/yr	4.9 mrad/yr
Dose to total body of an individual	5 mrem/yr	1.4 mrem/yr
Dose to skin of an individual	15 mrem/yr	3.5 mrem/yr
Radioiodine and Particulates[c]		
Dose to any organ from all pathways	15 mrem/yr	8.8 mrem/yr

[a]From "Concluding Statement of Position of the Regulatory Staff," Docket No. RM-50-2, Feb. 20, 1974, pp. 25-30, U. S. Atomic Energy Commission, Washington, D. C.

[b]PVNGS has no liquid dose pathways.

[c]Carbon-14 and tritium have been added to this category.

Table 2

Comparison of Calculated Doses from
Palo Verde Nuclear Generating Station Operation
with Sections II.A, II.B and II.C
of Appendix I, 10 CFR 50
(Doses to Maximum Individual per Reactor Unit)

Criterion[a]	Appendix I Design Objective	Calculated[b] Doses		
		Unit 1	Unit 2	Unit 3
Noble Gas Effluents				
Gamma dose in air (mrad/yr)	10	0.81	0.71	0.70
Beta dose in air (mrad/yr)	20	1.8	1.5	1.5
Dose to total body of an individual (mrem/yr)	5	0.50	0.43	0.43
Dose to skin of an individual (mrem/yr)	15	1.3	1.1	1.1
Radioiodines and Particulates[c]				
Dose to any organ from all pathways (mrem/yr)	15	3.3	2.8	2.7

[a] PVNGS has no liquid dose pathways.

[b] The per reactor unit doses reflect the effect of different meteorological parameters for each unit at the specific receptors.

[c] Carbon-14 and tritium have been added to this category.

Turning to Question 9 (regarding the amounts of I-131 which are likely to be released from the heat dissipation system and the resulting doses to man), I have examined the Applicant's analysis of January 21, 1976 (see attachment 1) which predicts the amount of I-131 which may be released via the heat dissipation system. I find that the assumptions and calculational method used by the Applicant are reasonable, and should not substantially underestimate the amount of I-131 leaving the heat dissipation system of the plant. The dose calculations (given below) based upon these releases indicate that I-131 from the Phoenix sewage system would have to be increased many times in order to give any significant dose to any human in the vicinity of the Palo Verde site.

As part of the customary Staff evaluation for nuclear power stations, radiological doses are evaluated for all potential exposure pathways to humans. Part of this evaluation considers the radiological dose from radioiodines derived from the gaseous radwaste system. This evaluation was made for the PVNGS and found to be only a small contributor to the potential radiological exposure to man, as is shown in the results of calculations presented below.

In addition to radioiodines from the radwaste system, the PVNGS has a unique source of I-131, that being the use of cooling water derived from the Phoenix sewage system which contains some I-131 effluent from hospitals. The use of this source of water has the potential of introducing I-131 into

the plant environs via the heat dissipation system. In order to give some perspective to the magnitude of the dose contribution of I-131 from the heat dissipation system, I have performed dose calculations to evaluate this source of potential radiation exposure and compared it with the radiological dose calculated for the radwaste system derived I-131.

Two exposure pathways were examined for each of the potential sources of radioiodines. The first of these pathways was the radiological dose to the thyroid of an infant from I-131 via the air-pasture-goat-milk pathway, and the second was the radiological dose to the thyroid of a child from I-131 via the air-vegetable pathway. These pathways were chosen for examination because they contribute the largest source of potential dose from I-131.

The dose models used to perform these calculations are contained in Draft Regulatory Guide 1AA. The assumptions used in the calculations provide a range of potential dose values bounded on the high side by what I consider to be the maximum dose.

Infant thyroid dose via the air-pasture-goat-milk pathway

The maximum calculated realistic dose to the thyroid of an infant (located 3.2 miles NW of Unit 1) via the air-pasture-goat-milk pathway was found to be 1.9 mrem/year. This dose was calculated for the gaseous and particulate releases from the radwaste system as part of the Staff's customary evaluation of potential dose pathways. The contribution of radioiodines to

this dose was only about 10%, the major contributors being C-14 and H-3.

The radioactivity source terms used in these calculations were 1) radioiodines and particulates derived from the radwaste system as provided by Mr. Bellamy and 2) I-131 (14mCi/year) derived from the heat dissipation system as provided by Applicant (as given in Attachment 1).

Table 3 gives the doses calculated for both radwaste system and heat dissipation system derived I-131, as well as radwaste system derived C-14 and H-3. Two estimates of dose are given for I-131, the first being for I-131 from the radwaste system and the second for I-131 from the heat dissipation system. Both elevated and ground level releases were considered for the heat dissipation system derived I-131.

Ground level releases lead to the maximum deposition of the radioiodines at the receptors of interest and therefore to the maximum dose. In addition, it is assumed that none of the radioiodine is lost close-in to the plant as a result of deposition with water droplets in the cooling tower drift. This also tends to maximize the dose.

The lower doses are based on the assumption that all of the I-131 from the heat dissipation system is released from the same points as the radwaste system gaseous releases. Again, the effect of cooling tower drift was ignored.

Child thyroid dose via the air-vegetable pathway

As discussed in response to Question 11, the maximum organ dose calculated in the Staff's pathway evaluation for gaseous radwaste system releases was 8.8 mrem/year. This dose was to the thyroid of a child from radioiodines and particulates via the air-vegetable pathway. As was true for the pasture-milk pathway, the dose calculated from radioiodines via vegetables is only a small fraction of the doses calculated for C-14 and H-3. Since the dose derived from I-131 via this pathway is not at its maximum at this residence location (1.2 miles E of Unit 1), an additional residence location (0.8 miles W of Unit 1), where the largest calculated I-131 dose could be received was selected for comparison purposes. Both ground level and elevated releases were considered for the heat dissipation system derived I-131, as was done in the calculations for the milk pathway.

The results of these calculations are presented in Table 4. The assumptions and source terms used for these calculations are the same as were used for the milk pathway.

Discussion

The assumption that the ground level release in gaseous form gives a conservative dose estimate is based on engineering judgment and consideration of the possible fate of I-131 released in association with water droplets from the cooling towers.

Any iodine associated with water droplets can follow one of several routes after discharge from the heat dissipation system. These routes are described as follows: 1) the iodine released from the droplets by evaporation, 2) it can remain with these droplets and be deposited on the ground where it may react with soil and plants or evaporate and become available for transport to the receptors considered above, and 3) it may be transported to receptors in the water droplets themselves. Since the effluent from the cooling tower drift is injected into the atmosphere where it is subjected to evaporation and deposition, it is more likely that a combination of the routes considered above occurs. Droplets with their associated I-131 depositing on site (it is expected that most will fall within 500 meters of the towers) will be subjected to absorption, chemical reactions with the surfaces which they contact and additional radioactive decay during the time that they remain on the surface. Some of the I-131 will thereby be removed from the exposure pathways considered. For the above reasons, and in order to derive the maximum doses, it was decided to use the conservative assumption that all the I-131 released at ground level were not influenced by being associated with water droplets.

As is indicated in Tables 1 and 2, the dose contribution of I-131 to the thyroid, from the two pathways most likely to expose this organ, is less than 1 mrem/year. This is true for the maximum dose calculation case as well. I consider these doses to be negligible.

Table 3. Comparative Infant Thyroid Dose Via The Air-Pasture-Goat-Milk Pathway For Radwaste System Derived I-131, C-14 and H-3; and Heat Dissipation System Derived I-131 for Elevated and Ground Level Releases From the Heat Dissipation System (Location is 3.2 miles NW of Unit 1)

		Dose (mrem/year)	
		Radwaste System	Heat Dissipation System
I-131	Elevated	0.2	0.1
	Ground Level		0.2
C-14	Elevated	0.7	
H-3	Elevated	1.0	

Table 4. Comparative Child Thyroid Doses Via The Air-Vegetable-Pathway at 2 Site Boundary Locations for Radwaste System Derived I-131, C-14 and H-3; and Heat Dissipation System Derived I-131 for Elevated and Ground Level Releases From the Heat Dissipation System

		Dose (mrem/year)		
		Radwaste System	Heat Dissipation System	
		Location 1*	Location 1	Location 2**
I-131	Elevated	0.06	0.03	0.05
	Ground Level		0.08	0.42
C-14	Elevated	4.0		
H-3	Elevated	4.7		

*Location 1: That location yielding the highest dose to the thyroid from all radionuclides (1.2 miles E of Unit 1)

**Location 2: That location yielding the highest dose to the thyroid of a child from I-131 (0.8 miles W of Unit 1)

References

1. 10 CFR Part 50, Appendix I. 40 FR 19442, May 5, 1975.

2. Letter from E. E. Van Brunt, Jr., Arizona Public Service, to Daniel R. Muller, NRC.

3. U. S. Atomic Energy Commission, Concluding Statement of Position of the Regulatory Staff (and its Attachment) - Public Rulemaking Hearing on: Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criteria "As Low As Practicable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactors, Docket No. RM-50-2, Washington, D. C., February 20, 1974.

4. Staff of the U. S. Nuclear Regulatory Commission. Draft Regulatory Guide 1.AA, "Calculation of Annual Average Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Implementing Appendix I," September 23, 1975.

5. Opinion of the Commission in the Matter of: Rulemaking Hearing - Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low As Practicable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents, Docket No. RM-50-2, CLI-75-5, NRCI-75/4R 277 (April 30, 1975).

ENUS CORPORATION
ENVIRONMENTAL SAFEGUARDS DIVISION
4 RESEARCH PLACE
ROCKVILLE, MARYLAND 20850
301 948-7010

ATTACHMENT 1

January 21, 1976
ESD-76-49 (HQ)

Dr. Mike Parsont
Nuclear Regulatory Commission
Site Safety and Environmental Analysis Division
7920 Norfolk Avenue
Bethesda, Maryland 20014

Dear Dr. Parsont:

In response to your verbal request for information regarding the calculational procedure and assumptions used to estimate the amount of radioiodine activity released in the cooling tower drift of the Palo Verde Nuclear Generating Station, the attached explanation is provided.

Please feel free to call us should you require further information on this matter.

Sincerely,

Joseph J. DiNunno
Vice President and
General Manager

BH/jw

Attachment

cc: John Mann
L. T. Klein

RESPONSE

A survey was done by NUS which identified nine hospitals upstream of the 91st Avenue Sewage Treatment Plant which had nuclear medicine facilities and could therefore discharge radioactive wastes into the sewage system. No radiopharmaceutical laboratories or other potential sources were identified.

Technical personnel from the nine hospitals were then interviewed to determine the amount of I-131 administered, per year, in both therapeutic and diagnostic procedures. It was reported that approximately 1,389 mCi were administered during 1973. The following assumptions were then applied:

- 30% of the amount administered to the patient is lost by decay in the thyroid gland, therefore 70% of the administered amount reaches the sewage system.(1)

- 10% of the radioiodine in the sewage influent is removed by primary and secondary treatment, therefore 90% of the influent amount leaves the sewage plant.(2)

- 83% is the maximum amount of the treated wastewater that will be diverted from the 91st Avenue Sewage Treatment Plant effluent stream to the PVNGS water reclamation plant (in 1985).(3)

- In 1985, the population is projected to have increased about 167% of the 1973 value. Radioiodine utilization per capita is assumed to remain constant at the 1973 value.(4)

Application of the aforementioned assumptions to the source term administered to the patients yielded approximately 1210 mCi of I-131 available to reach the PVNGS water reclamation plant in 1985 (the maximum amount during the lifetime of the facility).

In order to predict the ultimate fate and potential impact of the iodine of medical origin reaching PVNGS, the WRP, reservoir, circulating water system, cooling tower blowdown complex was mathematically modeled and iodine concentrations in the reservoir and circulating water system were calculated. Iodine released would be contained in the drift from the cooling towers, at the concentration in the circulating water system. It was conservatively assumed that the moisture in drift evaporates before reaching the ground, freeing the iodine to be transported as a gas. The following equilibrium model was used:

$$C_T = \frac{Fs \quad Cs}{(Fm + \lambda Mr)\left[\frac{Fb + Fc + \lambda Mt}{Fm}\right]} - Fb$$

where:

C_T = concentration of a cooling tower basin, mCi/lb
Fs = flow into Water Reclamation Plant, lbs/day
Cs = concentration I^{131} in Fs, mCi/lb
Fm = flow from reservoir, lbs/day
Mr = mass of water in the reservoir, lb
λ = decay constant of I^{131}, $days^{-1}$
Fb = flow from cooling tower to WRP, lbs/day
Fc = drift loss from cooling tower, lbs/day
Mt = mass of water in cooling tower basins/lbs

Input data necessary to solve the equation was furnished by the PVNGS PSAR and Bechtel Engineering, San Francisco, California.

Using the models just described together with the latest cooling tower specifications, it is estimated that, as a result of operation of the three units, about 1.2% of the I-131 reaching PVNGS in sewage water, or about 14 mCi, would be released to the atmosphere annually, the balance being decayed while in solution within the reservoir and circulating water system.

REFERENCES

(1) ICRP Publication 2, "Report of Committee on Permissible Dose for Internal Radiation," Internal Commission on Radiological Protection, Pergamon Press, New York (1959).

(2) Straub, Low-level Radioactive Wastes, Library of Congress, Catalog No. 64-60034.

(3) "PaloVerde Nuclear Generating Station - 1, 2 and 3 Environmental Report," Table 5.7-3, p. 5.7-8.

(4) "PaloVerde Nuclear Generating Station - 1, 2 and 3 Environmental Report," Section 2.2.

Statement of Professional Qualifications of Michael A. Parsont

My name is Michael A. Parsont. I am an Environmental Scientist in the Radiological Impact Section of the Radiological Assessment Branch of the Office of Nuclear Reactor Regulation. In this capacity I am responsible for writing Sections 5.4, Radiological Impact; 6.1.4, Preoperational radiological monitoring; and 6.2.4, Radiological monitoring of Final Environmental Statements for various nuclear power stations.

In addition, my responsibilities include the review of applicant Environmental Reports in the area of radiological effects on man and biota other than man, topical studies in radioecology and radiobiology and preparation of environmental monitoring technical specification and safety guide preparation. I hold a Bachelor of Science Degree in Environmental Sanitation (University of California at Los Angeles), a Masters Degree in Radiology and a Doctorate Degree in Radiation Biology (Colorado State University). I have additional academic background in Environmental Health, Sanitation Engineering and Zoology (endocrinology and genetics).

I have more than eight years of experience working in areas related to the evaluation of the biological effects from dispersed radionuclides. These include three years with the Aerospace Nuclear Safety Division at Sandia Laboratories, Albuquerque, New Mexico and two years at NUS Corporation, Rockville, Maryland.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

9/1/79

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
ARIZONA PUBLIC SERVICE COMPANY, et al.	)	Docket Nos. STN 50-528 STN 50-529 STN 50-530
	)	
(Palo Verde Nuclear Generating Station, Units 1, 2 and 3)	)	

SUPPLEMENTAL TESTIMONY OF NRC STAFF IN RESPONSE TO BOARD QUESTIONS 10 AND 11

Ronald R. Bellamy

This testimony is offered in response to Questions 10 and 11 posed by the Atomic Safety and Licensing Board, which read as follows:

> 10. If I-131 levels are found to be excessive, what are the control technology options available to be employed to reduce doses to within acceptable limits?
>
> 11. Provide the projected radioactive effluent releases and calculated doses expected from PVNGS based on the model appropriate for new Appendix I of 10 CFR 50 as determined by the Staff.

I will address Question 11 first.

Introduction

On December 3, 1970, the Atomic Energy Commission (now, the Nuclear Regulatory Commission) published an amendment to its regulations that

required releases of radioactive materials in effluents from nuclear power reactors to be kept "as low as practicable". By amendment dated December 19, 1975 (40 FR 58847) the Commission replaced the terminology "as low as practicable" with the terminology "as low as is reasonably achievable" (ALARA). This amendment was adopted to make the concept of radiation protection more understandable and to conform to the terminology used by the International Commission on Radiological Protection. We shall hereafter in this testimony use the terminology "as low as is reasonably achievable".

The term "as low as is reasonably achievable" is defined in the regulations (10 CFR 20.1(c) and 10 CFR 50.34a) to mean "as low as is reasonably achievable, taking into account the state of technology, and the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to the utilization of atomic energy in the public interest". The Commission recently published Appendix I to 10 CFR 50 (40 FR 19442, May 5, 1975), which set forth numerical guidelines for meeting "as low as is reasonably achievable" for light water reactors.

On September 4, 1975 (40 FR 40816) the Commission amended Appendix I to 10 CFR Part 50 to provide persons who have filed applications for construction permits for light-water-cooled nuclear power reactors which

were docketed on or after January 2, 1971, and prior to June 4, 1976, the option of dispensing with the cost-benefit analysis required by Paragraph II.D of Appendix I. This option permits an applicant to design his radwaste management systems to satisfy the Guides on Design Objectives for Light-Water-Cooled Nuclear Power Reactors proposed in the Concluding Statement of Position of the Regulatory Staff in Docket RM-50-2, dated February 20, 1974. As indicated in the Statement of Considerations accompanying the amendment (copy attached), it is unlikely that further reductions to radioactive material releases would be warranted on a cost-benefit basis for light-water-cooled nuclear power reactors having radwaste systems and equipment determined to be acceptable under the proposed Staff design objectives set forth in RM-50-2.

In a letter to the Commission dated September 26, 1975, Arizona Public Service Company (the Applicant) chose the option of dispensing with the cost-benefit analysis required by Paragraph II.D of Appendix I and chose to comply with the September 4 amendment of Appendix I instead. The Applicant also provided information requested to permit determination by the NRC Staff of compliance with the design objectives of Paragraphs II.A, B, and C of Appendix I.

Evaluation

The Staff has evaluated the gaseous radwaste management systems proposed for Palo Verde Nuclear Generating Station, Units 1, 2 and 3 (PVNGS), to reduce the quantities of radioactive materials released to the environment in gaseous effluents. The Staff has evaluated the liquid radwaste management system and found there will be no discharges of liquid effluents to the environment. These systems have been previously described in Sections 11.2 and 11.3 of the Staff's Safety Evaluation Report, dated October 1975, and in Section 3.5 of the Final Environmental Statement, dated September 1975. In accordance with Appendix I, as amended, and based on information provided by the Applicant in the above referenced letter, on more recent operating data applicable to PVNGS, and on changes in our calculational model, the Staff generated new gaseous source terms in order to calculate releases from the site by PVNGS. These values are different from and supersede those given in Tables 3.4 and 3.4A of the Final Environmental Statement.

The new source terms, shown in Attachment 1, were calculated using the models and methodology described in Draft Regulatory Guide 1.BB, "Calculation of Releases of Radioactive Materials in Liquid and Gaseous Effluents from Pressurized Water Reactors (PWRs)", September 9, 1975. These source terms were used by Dr. Parsont to calculate the doses presented in his testimony.

Based on the Staff's evaluation of the gaseous radwaste management systems and on the dose calculations presented by Dr. Parsont in his testimony, the calculated total quantity of radioactive materials released in gaseous effluents from PVNGS, will result in a calculated annual gamma air dose of less than 10 mrads and a calculated annual beta air dose of less than 20 mrads at every location near ground level, at or beyond the site boundary, which could be occupied by individuals. The calculated annual total quantity of iodine-131 released in gaseous effluents will not exceed 1 Ci/reactor and the calculated annual total quantity of radioiodine and radioactive particulates released in gaseous effluents from PVNGS, will not result in an annual dose or dose commitment to any organ of an individual in an unrestricted area from all pathways of exposure in excess of 15 mrem.

Conclusion

Staff testimony demonstrates that the doses associated with the normal operation of the PVNGS, meet the design objectives of Sections II.A, II.B and II.C of Appendix I of 10 CFR Part 50, and that the expected quantity of radioactive materials released in gaseous effluents and the aggregate doses meet the design objectives set forth in RM-50-2.

Staff's evaluation shows that the Applicant's proposed design of the PVNGS satisfies the criteria specified in the option provided by the Commission's September 4, 1975 amendment to Appendix I and, therefore, meets the requirements of Section II.D of Appendix I of 10 CFR Part 50.

Based on the Staff's evaluation, the proposed gaseous radwaste management system for PVNGS meets the criteria given in Appendix I and is, therefore, acceptable.

ATTACHMENT 1

CALCULATED RELEASES OF RADIOACTIVE MATERIALS IN GASEOUS EFFLUENTS FROM PALO VERDE NUCLEAR GENERATING STATION, UNITS 1, 2 AND 3

(Ci/yr/unit)

	Release Point				
Nuclides	Turbine Vent	Plant Vent	Fuel Bldg. Vent	Air Ejector Vent	Total
Kr-83m	a	a	a	a	a
Kr-85m	a	4	a	1	5
Kr-85	a	270	a	a	270
Kr-87	a	1	a	a	1
Kr-88	a	6	a	3	9
Kr-89	a	a	a	a	a
Xe-131m	a	9	a	a	9
Xe-133m	a	21	a	1	22
Xe-133	a	1900	a	63	2000
Xe-135m	a	a	a	a	a
Xe-135	a	16	a	4	20
Xe-137	a	a	a	a	a
Xe-138	a	a	a	a	a
I-131	2.2(-4)	4.5(-3)	c	2.7(-3)	7.4(-3)
I-133	3(-4)	6.4(-3)	c	3.9(-3)	1.1(-2)
Co-60	c	3.4(-4)[b]	c	c	3.4(-4)
Co-58	c	7.6(-4)	c	c	7.6(-4)
Fe-59	c	7.6(-5)	c	c	7.6(-5)
Mn-54	c	2.3(-4)	c	c	2.3(-4)
Cs-137	c	3.8(-4)	c	c	3.8(-4)
Cs-134	c	2.3(-4)	c	c	2.3(-4)
Sr-90	c	3.0(-6)	c	c	3.0(-6)
Sr-89	c	1.6(-5)	c	c	1.6(-5)
C-14		9			9
H-3		1125	375		1500
Ar-41		25			25

a = less than 1.0 Ci/yr noble gases, less than 10^{-4} Ci/yr for iodine.

b = exponential notation: 7.0(-5) = 7.0×10^{-5}

c = less than 1% of total for nuclide.

I now turn to Question 10, which concerns control technology options available if iodine - 131 release levels resulting from the use of the sewage effluent are found to be excessive at the PVNGS. The testimony of Dr. Parsont indicates that the doses anticipated to result from the dispersion of the I-131 will be negligible. Nevertheless, we offer the following comments in response to the Board's question.

The releases of concern result from the presence of iodine-131 in the plant cooling tower water prior to delivery to the onsite water reclamation plant. The source of plant cooling tower water is the waste water effluent from the City of Phoenix 91st Avenue Sewage Treatment Plant. This water is used to remove waste heat resulting from normal operation of the PVNGS and reject it to the atmosphere via the cooling towers in the system. Entrained water droplets (mist) are carried away in the cooling tower effluent air stream. Iodine-131 in the plant cooling tower water entering the plant will be released in this mist.

Conventional treatment methods to remove iodine-131 in the plant cooling tower water would include demineralizers (mixed bed, powdex, or anion), and charcoal adsorbers. These systems, however, appear impractical to treat the large volume of water expected for Palo Verde (approximately 50,000 gallons per minute).

Once the iodine-131 becomes airborne at the cooling tower as a mist, it becomes entrained in the 6.3×10^7 cubic feet per minute per unit air draft. Air draft is provided by a 28 ft. diameter electric fan on the top of each cooling cell (14 cells per tower, 3 towers per unit). If this air draft were treated, it would require collection (confinement) and filtration through an adsorbent such as charcoal. The largest filter/adsorber systems yet designed have a capacity of the order of 10^5 cfm. Therefore, it would appear impractical to collect and filter the existing cooling tower air draft flow of 6.3×10^7 cfm with filter/adsorber systems.

The primary option, therefore, to reduce iodine-131 releases from the cooling tower mist would be to reduce the iodine-131 contamination of the plant cooling tower water supply at its source.

flexibility, it can be ensured that the average population exposure will still be a small fraction of doses from natural background radiation. The Commission notes, however, that, in using this operational flexibility under temporary or short-term unusual operating conditions, the licensee must continue to exert his best efforts to keep levels of radioactive material in effluents within the numerical guides for design objectives.

In order to provide assurance that releases of radioactive materials are known, the Commission has expanded the surveillance and monitoring program beyond current requirements for licensees to report on the quantities of the principal radionuclides released to unrestricted areas. It is expected that this expanded monitoring program will be used by licensees as a basis for initiating prompt and effective corrective action towards ensuring that the actual offsite exposures per reactor are compatible with the design objectives as adopted.

These guides will continue to provide operating flexibility and at the same time ensure a positive system of control by a graded scale of action first by the licensee and second by the Commission, if the need arises, to reduce the release of radioactive material should the rates of release actually experienced substantially exceed the design objectives.

7. *Implementation.* The proposed Appendix I was silent on the method for implementation of the numerical guides. The Commission believes, however, that Appendix I should guide the Commission Staff and other interested persons in the use of appropriate calculational procedures for applying the numerical guides for design objectives. Consequently, the provision adopted states that compliance with the guides on design objectives shall be demonstrated by calculational procedures based on models and data that will not substantially underestimate the actual exposure of an individual through appropriate pathways, all uncertainties being considered together.

Quantitative measurement of radioactive materials released in effluents from licensed light-water-cooled nuclear power reactors is required by 10 CFR 50.36a. This requirement is made more specific by Appendix I and reflects the desirability of the use of the best available experimental data as well as calculational models in order to achieve increased accuracy and realism. Strong incentives already exist for improving the calculational models used in establishing design objectives in view of the economic penalty associated with needless overdesign for conservatism. Actual measurements and surveillance programs can provide data for improving these models. It is recognized, however, that measurements of environmental exposures and quantities of radioactive materials in the environs are complicated by the very low concentrations that are encountered, compared to background, and by the fact that there are a number of variables in both time and space that affect concentration. Thus, the correlation of the best measurements with the best calculations is tedious and difficult. However, since calculational procedures must be employed in implementing the design-objective guides of Appendix I, the Commission has adopted an implementation policy that encourages the improvement of calculation models and the use of the best data available.

The foregoing "Summary and Statement of Considerations" has briefly summarized the technical context of the issues presented and outlined the changes made in Appendix I from the form in which it was originally proposed. The text of Appendix I as adopted follows in Chapter II of this Opinion. The three following chapters of text set forth the record bases for the changes in greatly expanded detail. These supplemental explanatory chapters (III through V), because of their length, will not be published in the FEDERAL REGISTER with the text of Appendix I and the Summary and Statement of Considerations, but will be published in the April issue of Nuclear Regulatory Commission Issuances.* Single copies of this volume may be purchased at a cost of $4.00 from the USERDA Technical Information Center, P.O. Box 62, Oak Ridge, Tennessee, 37830. Copies of the complete Opinion are also available for inspection and copying in the Commission's Public Document Room, 1717 H Street, NW., Washington, D.C. 20555.

Pursuant to the Atomic Energy Act of 1954, as amended, and Sections 552 and 553 of Title 5 of the United States Code, the following amendments to Title 10, Chapter I, Code of Federal Regulations, Part 50, are published as a document subject to codification to be effective on June 4, 1975.

40 FR 40816
Published 9/4/75
Effective 9/4/75

PART 50—LICENSING OF PRODUCTION AND UTILIZATION FACILITIES

Application of Cost-Benefit Analysis Requirements of Appendix I to Certain Nuclear Power Plants

The Nuclear Regulatory Commission has adopted amendments to Appendix I of 10 CFR Part 50. Appendix I sets forth numerical guides for design objectives and limiting conditions for operation to meet the criterion "as low as practicable" for radioactive material in light-water-cooled nuclear power reactor effluents. The amendments provide persons who have filed applications for construction permits for light-water-cooled nuclear power reactors which were docketed on or after January 2, 1971, and prior to June 4, 1976, the option of dispensing with the cost-benefit analysis required by Paragraph II.D of Appendix I if the proposed or installed radwaste systems and equipment satisfy the Guides on Design Objectives for Light-Water-Cooled Nuclear Power Reactors proposed by the regulatory staff in the rulemaking proceeding on Appendix I (Docket-RM-50-2).

Paragraph II.D requires each applicant for a permit to construct a light-water-cooled nuclear power reactor to submit a cost-benefit analysis of additional radwaste systems and equipment that could reduce the radiation dose to the population reasonably expected to be within 50 miles of the reactor. In this cost-benefit analysis, the values $1000 per total body man-rem and $1000 per man-thyroid-rem (or such lesser values as may be demonstrated to be suitable in a particular case) are required to be used. The requirements of Paragraph II.D embody an approach somewhat different from the proposed Appendix I published for comment on June 9, 1971 (36 FR 11113).

After a lengthy Appendix I rulemaking proceeding initiated in 1971 which was conducted by the former Atomic Energy Commission, the Nuclear Regulatory Commission, which was assigned the responsibility of carrying out the licensing and related regulatory functions of the Atomic Energy Commission by the Energy Reorganization Act of 1974 (effective January 19, 1975), adopted on May 5, 1975, a new Appendix I to Part 50 (40 FR 19439).

Appendix I provides numerical guides for design objectives and limiting conditions for operation for light-water-cooled nuclear power reactors to keep radioactivity in effluents as low as practicable. All Commission licensees are required by 10 CFR Part 20 to make every reasonable effort to maintain radiation exposures, and releases of radioactive materials in effluents to unrestricted areas, as far below Part 20 limits as practicable. The definition of "as low as practicable" in both 10 CFR §§ 20.3(c) and 50.34a(a) includes consideration of the economics of improvements in relation to the public health and safety.

Appendix I as adopted by the Commission provides in Section II—in addition to design objectives for annual doses for any individual in an unrestricted area from both liquid and gaseous effluents, including radioactive iodine and radioactive material in particulate form—a further requirement that the applicant include in the radwaste system all items of reasonably demonstrated technology that, when added to the system sequentially and in order of diminishing cost-benefit ratio, effect reductions in dose to the population reasonably expected to be within 50 miles of the reactor. As an interim measure and until establishment and adoption of better values (or other appropriate criteria), the values $1000 per total body man-rem and $1000 per man-thyroid-rem (or such lesser values as may be demonstrated to be suitable in a particular case) are to be used in this cost-benefit analysis. A rulemaking hearing is planned at the earliest practicable date to establish more appropriate monetary values for the worth of reduction of radiation doses to the population.

The design objectives proposed by the

* Copies of the complete five-chapter Opinion of the Commission have been filed with the original document submitted for publication in the FEDERAL REGISTER, and may be examined by members of the public at the Offices of the Federal Register.

staff in the rulemaking proceeding on Appendix I included specifications on the total radioactivity released (5 curie/per year reactor for liquid effluents, excluding tritium and dissolved gases; and 1 curie/per year per reactor of radioiodine-131) and a 5 millirem limitation on the annual whole body dose to individuals at or beyond the site boundary from all pathways of exposure. Because the former criterion used by the staff that each plant meet those design objectives has led to the proposed or actual installation of radwaste systems and equipment that reduce to low levels the total activity in effluent releases or expected effluent releases from such plants, the application of the $1000 per man-rem criterion specified in Paragraph II.D of Appendix I to these or similarly designed plants is unlikely to result in radwaste equipment augmentation.

Cost-benefit analyses by the NRC staff of applications for construction permits for light-water-cooled nuclear power reactors filed and reviewed since 1971 in accordance with those design objectives show that for boiling water reactors, additional radwaste equipment cannot be added for less than $1000/man-rem. Therefore, in general, boiling water reactors that have radwaste systems and equipment that meet those proposed design objectives will meet the requirements of Section II.D of Appendix I. Similar cost-benefit analyses have shown that pressurized water reactors whose radwaste systems have been evaluated and found acceptable under those design objectives also meet the requirements of Section II.D of Appendix I.

Basic assumptions used in these analyses were: (1) Iodine-131 in gaseous releases was the only release considered, since this is the dominant factor in the cost-benefit analyses; (2) boiling water reactor condenser offgas and pressurized water reactor waste gas treatment systems were considered to be augmented in order to meet the individual dose guidelines proposed by the staff in the Appendix I rulemaking proceeding; (3) a release of 1 curie of iodine-131 results in a population exposure of 100 man-thyroid-rem. The assumption that iodine-131 in gaseous releases is the dominant factor is based on the results of staff evaluations, reported in draft and final environmental impact statements, of proposed light-water-cooled nuclear power reactors for which applications for construction permits were docketed since 1971. The total body man-rem associated with noble gas and liquid releases for radwaste systems and equipment found acceptable under the design objectives proposed by the staff were small, i.e., less than 10 man-rem for the annual noble gas releases and less than 5 man-rem for the annual liquid releases in almost all cases. As a consequence, it can reasonably be concluded that reduction of population dose by augmentation of the noble gas and liquid radwaste treatment systems was not likely to be achieved without exceeding the $1000/man-rem criterion.

A. *Boiling Water Reactor Cost-Benefit Analyses.* Sources of radioiodine releases in boiling water reactors are:

1. Reactor building vent.
2. Auxiliary building vent.
3. Radwaste building vent.
4. Turbine building vent.
5. Turbine gland seal condenser exhaust.
6. Main condenser vacuum pump.
7. Condenser air ejector exhaust.

The last source was assumed to be treated such that the iodine-131 release is negligible compared with the other sources.

Additional radwaste equipment considered included: charcoal adsorbers for building ventilation exhaust (Sources 1, 2, 3, 6) and equipment for clean sealing steam for the turbine gland seal exhaust and for sealing valve stems in the steam system (Sources 4, 5). The charcoal adsorbers reduce the iodine-131 release to approximately 10% of the expected release without the filters. The turbine gland seal condenser exhaust releases can be reduced to negligible levels by the use of clean steam. Releases from the turbine building vent can be reduced approximately 80% by using clean steam on valves, 2.5-in. and larger, in the turbine building.

The cost of the additional equipment is greater than the benefit of reduced population exposure (at $1000/man-rem) in all cases. Accordingly, such additional equipment for boiling water reactors would not be justified according to the criterion of Section II.D of Appendix I.

B. *Pressurized Water Reactor Cost-Benefit Analyses.* Sources of iodine-131 releases in pressurized water considered were:

1. Containment.
2. Auxiliary building vent.
3. Turbine building vent.
4. Condenser air ejector exhaust.
5. Blowdown flash tank vent.

Reduction in released activity can be achieved with charcoal adsorbers (Sources 1, 2, 4), with clean sealing steam for valves (Source 3), and by installation of a piped blowdown flash tank vent to the main condenser or feedwater heater (Source 5). As with boiling water reactors, charcoal adsorbers can reduce the activity approximately 90 per cent. Clean sealing steam effects an 80% reduction in releases. The blowdown flash tank vent source can be eliminated by routing the release to the main condenser or feedwater heater.

With respect to the pressurized water reactor containment as a source of effluent release, the estimated cost of charcoal adsorbers was based upon a plant having a low volume purge system in the initial design stage. Charcoal adsorbers cannot be installed in plants which have a high volume purge system for less than $1000/man-rem. Most pressurized water reactors for which license applications have been docketed after January 2, 1971, fall into this latter category. Those which have a low volume purge system are located on sites where the reduction in population exposure is less than 100 man-rem per curie of iodine-131, so that the cost of installation of charcoal adsorbers is greater than $1000/man-rem.

Based on the foregoing, there is no need, on a cost-benefit basis, to apply the requirements of Paragraph II.D of Appendix I of Part 50 to those light-water-cooled nuclear power reactors having radwaste systems and equipment determined to be acceptable under the proposed staff design objectives. Accordingly, Paragraph II.D of Appendix I has been amended to specify that persons who have filed applications for construction permits for light-water-cooled power reactors which were docketed on or after January 2, 1971, and prior to June 4, 1976, need not comply with the cost-benefit requirements of that paragraph if the radwaste systems and equipment described in the preliminary or final safety analysis report and amendments thereto satisfy the design objectives proposed by the staff in the Appendix I rulemaking proceeding.

Because the amendments will result in no appreciable change in the population exposure from the affected plants than would result if the amendments were not promulgated, the Commission has found that notice of proposed rulemaking and public procedure thereon are unnecessary. Since the amendments relieve from restrictions imposed under regulations currently in effect, they may, pursuant to 5 U.S.C. 553, become effective immediately.

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974 and sections 552 and 553 of Title 5 of the United States Codes, the following amendments to Title 10, Chapter 1, Code of Federal Regulations, Part 50, are published as a document subject to codification.

≫40 FR 58847
Published 12/19/75
Effective 1/19/76

PART 20—STANDARDS FOR PROTECTION AGAINST RADIATION

PART 50—LICENSING OF PRODUCTION AND UTILIZATION FACILITIES

Change of Terminology for "As Low As Practicable" Limits

On May 5, 1975, the Nuclear Regulatory Commission published in the FEDERAL REGISTER its decision in the rule making proceeding concerning numerical guides for design objectives and limiting conditions for operation to meet the criterion "as low as practicable" for radioactive material in light-water-cooled nuclear power reactor effluents, including amendments of 10 CFR Part 50 which became effective June 4, 1975.

In its decision, the Commission noted that during the pendency of the rule making, the International Commission on Radiological Protection, in ICRP Publication No. 22 has replaced the phrase "as low as practicable" with "as low as is reasonably achievable" in its recommendation on dose limitation. The Commission, in its decision, endorsed the attempt to make this basic concept of radiation protection more understandable and directed the staff to prepare and issue for public comment a proposed rule that would substitute the currently accepted phrasing "as low as is reasonably achievable" for the older, less precise terminology where it appears in the

Dr. Ronald R. Bellamy
Professional Qualifications
Effluent Treatment Systems Branch, NRR

My name is Dr. Ronald R. Bellamy. I am a Nuclear Engineer in the Effluent Treatment Systems Branch, in the Office of Nuclear Reactor Regulation. I attended Lehigh University and received a Bachelor of Science Degree in Chemical Engineering in 1969. I attended Ohio State University and received a Master of Science Degree in Nuclear Engineering in 1970 and a Doctor of Philosophy Degree in Nuclear Engineering in 1973. The title of my dissertation was "The Adsorption of Elemental Iodine and Methyl Iodide on Activated Charcoal from Flowing Air Streams at Low Inlet Concentration." While performing my graduate studies at Ohio State University, I worked for CVI Corporation as a nuclear engineer in the engineering department. In this position I assisted in the design of BWR charcoal delay offgas treatment systems, including sizing, expected performance, seismic analysis, and preparation of operating procedures. I also participated in the design of air filtration systems, and performed laboratory charcoal adsorption studies.

In 1973 I joined the Nuclear Regulatory Commission (formerly AEC) as a nuclear engineer in the Effluent Treatment Systems Branch, Division of Site Safety and Environmental Analysis. In this position I am responsible

for the review and evaluation of radwaste treatment systems and for the calculation of releases of radioactivity from nuclear power reactors. I have participated in generic studies of the relationship between reactor operation and radwaste generation, in the preparation of staff papers and regulatory guides related to effluent control technology.

I am a member of the American Nuclear Society. I currently serve on the ANS 32.3 Working Group - Safety Related Ventilation Systems Outside Containment and the ANSI N45.8 Subcommittee - Nuclear Power Plant Air and Gas Cleaning Systems.

9/1/79

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
ARIZONA PUBLIC SERVICE COMPANY	)	Docket Nos. STN 50-528
	)	STN 50-529
(Palo Verde Nuclear Generating	)	STN 50-530
Station, Units 1, 2, and 3)	)	

SUPPLEMENTAL TESTIMONY OF NRC STAFF IN RESPONSE TO BOARD QUESTION 12

by

Thomas W. Green

This testimony is being offered in response to Atomic Safety and Licensing Board Question 12, which reads as follows:

> Give the provisions that will be required of the applicant to provide grounding of all structures likely to develop a shock hazard along transmission line rights-of-way and on space adjacent to the right of way.

The applicant will ground all transmission tower structures in a manner most appropriate to the tower type (e.g. wood tower will have #4 aluminum wire on the pole bonded to #4 copper wrapping around the portion of the post sunk in the ground). All fences, metal gates and similar devices within the right-of-way will be grounded by connecting all strands of the fence and at least one gate hinge to a metal post which is driven into the ground. Fences which parallel the transmission line will be grounded as described above at least once every 700 feet, or in other such manner as to prevent a section from becoming insulated by cutting the fence in one place.[1] These provisions are acceptable to the staff.

Since the applicant's policy is to locate transmission lines more than 500 feet from inhabited dwellings, no specific provisions have been made for grounding various types of structures other than fences and their associated hardware. However, since final rights-of-way have not been selected, the staff is unable to verify whether such structures will be avoided. Therefore the staff will require the applicant to follow appropriate grounding precautions, if necessary.[2]

References

1. Informal communication with officials of the Arizona Public Service Company and Southern California Edison Company, to be followed by formal submittal.

2. FES, pp. 5-19,20.

PROFESSIONAL QUALIFICATIONS

Thomas W. Green

Argonne National Laboratory

I, Thomas W. Green, am an assistant ecologist in the Environmental Statement Project at Argonne National Laboratory. My present duties include the analysis of Environmental Reports and the preparation of Environmental Impact Statements.

I have a Bachelor of Science degree in Wildlife Conservation (1968), a Bachelor of Arts degree in Zoology (1968) and a Master of Arts degree in Biology (1970) from California State University-Humboldt. I also have a Doctor of Philosophy degree in Plant Ecology (1973) from Utah State University.

My career has been mainly as a student in various areas of Biology-Ecology. I have taught (singley or team) several courses in biology and ecology in addition to a course in man and the environment. In 1971 and 1972 I served as Vice-President of the Cache Council for Environmental Quality and participated in the Speakers Bureau of that organization. From August 1973 to July 1974 I held a post-doctoral fellowship at the University of Houston where I was interim associate director of the Coastal Research Center. This position included part time work with local high schools and junior colleges on the impact of man on the gulf-coast environment.

My research has been in the areas of physiological reaction to stress environments (1966-1968), plant allelopathy (1968-1970), the effect of insect seed predators on the evolution and dynamics of plant populations

(1970-1974). At the present time I have 2 publications in print, 1 in press and 2 in review, all of which deal with the plant-herbivore interface. I have presented 4 papers at national meetings in the last 3 years.

I am presently a member of the Ecological Society of America, American Botanical Society, American Association for the Advancement of Science, American Institute of Biological Sciences, Society for the Study of Evolution, Society of the Sigma Xi, American Midland Naturalists. Several of these memberships are held jointly with my wife. I have also held membership in The Wildlife Society, American Society of Mammalogists, and the Scientists Institute for Public Information (Environment).

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
ARIZONA PUBLIC SERVICE COMPANY	)	Docket Nos. STN 50-528
	)	STN 50-529
(Palo Verde Nuclear Generating Station, Units 1, 2, and 3)	)	STN 50-530
	)	

SUPPLEMENTAL TESTIMONY OF NRC STAFF IN RESPONSE TO BOARD QUESTION 7

by

James E. Carson and Ronald A. Zussman

This testimony is being offered in response to Atomic Safety and Licensing Board Question 7 which reads as follows:

> Evaluate the collective effect of all PVNGS cooling towers in dispersing pathogenic organisms with regard to the dust-devil phenomenon.

Dust devils are small but vigorous whirlwinds of short duration, rendered visible by dust or sand picked up from the ground.[1] They should not be confused with tornadoes, however. Dust devils are formed by an entirely mechanism than are tornadoes (which are formed in clouds and the vortex moves downward) and are usually much weaker.

They are best developed on clear, calm afternoons in dry areas when intense solar heating of the ground surface (surface temperatures of the order of 150°F) creates a very unstable stratification of air. This unstable condition (cooler, denser air overlying the very hot, less dense surface air) is frequently relieved by airflow into small areas where upward air motions are concentrated; angular momentum of the original air flow tends to be conserved and concentrated into the familiar rotating core of the dust device.[2,3] Dust devils come in a range of sizes. Diameters vary from 10 to more than 100 feet, and heights from a hundred to 3000 feet.[1-4] Most dust devils are of short duration (two to three minutes) and cause no damage; a few may grow to very large size, last for long periods (hours) and may do significant damage to structures in their paths.[2,3] Recent lidar observations of flow indicate horizontal speeds up to 49 mph.[4]

Airflows in dust devils tend to disperse particles lifted from the surface; after the vortex dissipates, the particles will fall to the ground over a larger area than the area scoured by the wind. Thus, dust devils are able to resuspend materials lying on the soil surface in the path of the vortex, and would likely be able to redisperse pathogens, if any, in the vicinity of the PVNGS cooling towers.

However, in view of the immeasurably small numbers of viable pathogens[9] expected to be on the desert soil as a result of PVNGS operations, and the expected short lifetimes of most pathogens due to the sterilizing effects of intense sunlight[5,6,7,8] (during the lifetime of the whirlwind, as well as before and

after the event)*, photo-oxidation,[6] and dessication,[7] the staff expects no impacts, whatsoever, due to the interaction of dust devils, cooling towers, and pathogens.

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*Figure 1 shows the relative effectiveness of radiant energy from 2000 to 7000 nm(A^{o}). In the relatively pure air of the desert, the atmosphere is known to pass wavelengths above 2900 nm, relatively close to the germicidal peak of 2600 nm shown in the figure.

Figure 2 shows typical exposures (intensity x time) for killing of a variety of microorganisms. The intensity of radiation at approximately 2900-4000 nm is approximately 1000 to 2000 microwatts/cm^2 (typical for the Arizona desert). Although Figure 2 shows the killing effect of ultraviolet at lower radiation levels, extrapolation indicates that virtually all microorganisms would be killed within seconds in the radiation flux at the PVNGS.

Both figures are taken from Reference 7, below.

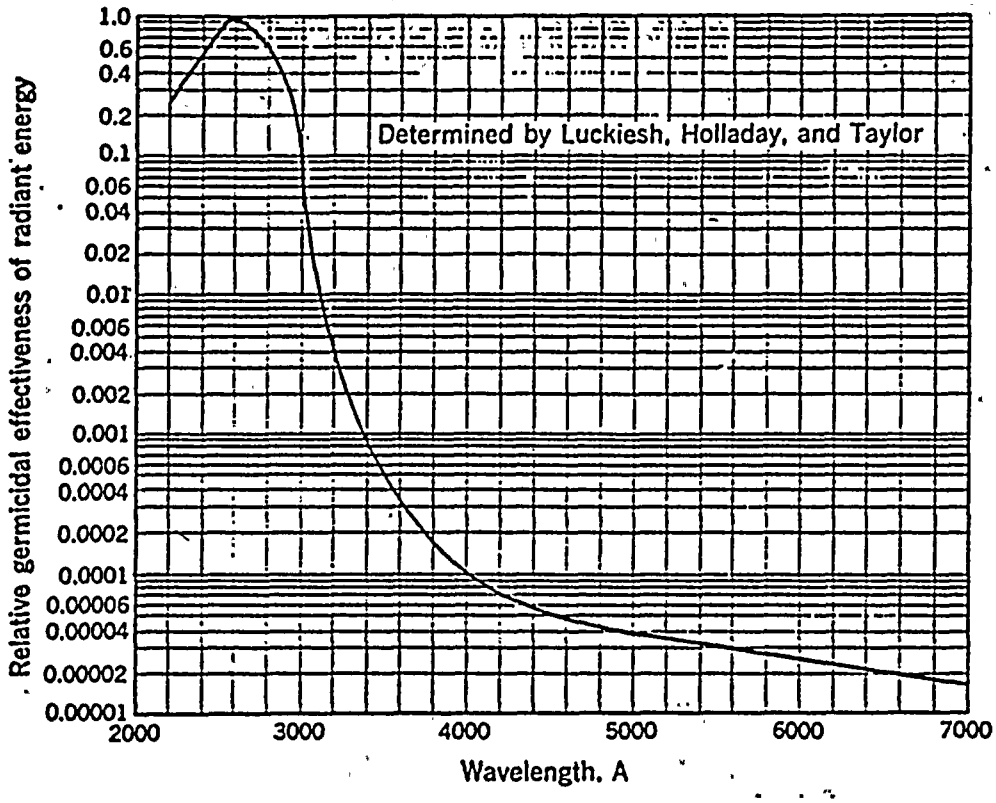

Figure 1.

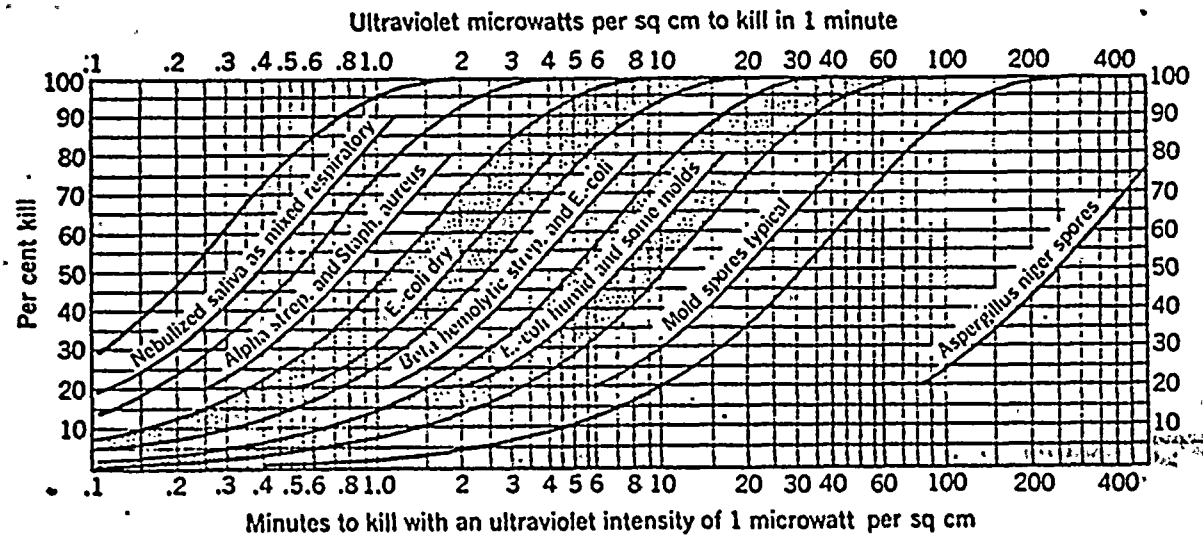

Figure 2.

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2. S. B. Idso, "Tornado or Dust Devil: The Enigma of Desert Whirlwinds," Amer. Scientist, 62, 530-541, 1974.

3. S. B. Idso, "Whirlwinds, Density Currents, and Topographic Disturbances; A Meteorological Melange of Intriguing Interactions", Weatherwise, 28, 61-65, 1975.

4. R. L. Schwiesow and R. E. Cupp, "Remote Doppler Velocity Measurements of Atmospheric 'Dust Devil' Vortices," to be published in Applied Optics, 1976.

5. B. D. Davis, "Principles of Sterilization - Chapter 32," Bacterial and Mycotic Infections of Man, 3rd Ed., R. J. Dubos, editor, J.B.Lippincott Co., Phila., Pa., 1958.

6. E. W. Nester, et al., Microbiology, Part IV, Holt, Rinehart, and Winston, Inc., N. Y., 1973.

7. M. J. Pelczar and R. D. Reid, Microbiology, McGraw-Hill, N. Y., pp. 216 - 218, 1958.

8. S. E. Luria and J. E. Darnell, Jr., General Virology, Second Ed., Wiley, Inc., N. Y., Chapter 7, 1967.

9. FES, 5.6.1.4

PROFESSIONAL QUALIFICATIONS

James E. Carson

Argonne National Laboratory

I am a meteorologist in the Environmental Statement Project (ESP) of Argonne National Laboratory (ANL). My primary task is to write the meteorological sections (climatology and dispersion characteristics of the site, atmospheric effects of the cooling system, etc.) for the Environmental Statements for nuclear power plants and fuel facilities.

I joined Argonne's Meteorology Group in May 1961 and transferred to ESP in April 1972. I have a Bachelor of Science degree in chemistry from Kent State University (1943). I did my graduate work in meteorology at The University of Chicago, receiving the Master of Science degree in 1948 and the Ph.D. degree in 1960.

I served as a weather officer and forecaster in the Air Force. While in graduate school, I served in various capacities, such as an instructor and as a research assistant. I was an Assistant Professor in the Meteorology Department at Rutgers University from 1951 to 1953, a meteorologist in the Army Quartermaster R & D Center in Natick, Massachusetts from 1953 to 1955 and an Assistant Professor of Physics at Iowa State University in Ames from 1955 to 1961.

While at Argonne National Laboratory, I have been involved in a variety of projects, including soil temperature and heat flux studies,

smoke dispersion and plume rise measurements, urban dispersion models and the atmospheric effects of thermal discharges from power plants. I have about 38 technical publications.

I am a member of the following professional societies: American Meterological Society (Professional Member); Air Pollution Control Association; and Sigma XI. I am a member of APCA's TT-3 (Meterorology) Technical Committee.

PROFESSIONAL QUALIFICATIONS

Ronald A. Zussman

Argonne National Laboratory

My name is Ronald A. Zussman. I am on the staff of the Environmental Statement Project of Argonne National Laboratory. My principal responsibility is that of Project Leader in the preparation of Environmental Impact Statements. My title is that of Staff Biologist. In this capacity I also participate in the evaluation of biological environmental impacts of proposed nuclear power generating stations as assigned to me. Included in these responsibilities are considerations of disease and public health as related to nuclear power plant construction and operation. I also contribute to other environment-associated projects, both within my department and as a consultant. I am a member of the Laboratory's Bioconversion Committee. I joined the Environmental Statement Project in September 1972.

When schedules have allowed, I have also taught on a part-time basis at the graduate level in the Department of Biology, Roosevelt University, Chicago, Illinois.

I have a Bachelor of Science degree in Biology from Loyola University of Chicago, and a Master of Science degree and a Doctor of Philosophy degree in Microbiology from the University of Illinois at the Medical Center, Chicago.

From 1964 until 1972 I was employed in the Biological Sciences Division of Abbott Laboratories, Inc., North Chicago, Illinois. During this period I worked in both the Microbiology and Molecular Biology Departments. My principal assignments were in basic and applied research related to Biology, Invertebrate Pharmacology, Virology, Parasitology, Microbiology, and Immunochemistry. My major efforts in Invertebrate Pharmacology involved the study of the effects of biologically active agents upon Daphnia, Stylaria, Artemia,

Hydra, Planaria, and various Protozoans. My interests in Virology were focused principally upon Herpesvirus, Influenzavirus, and Bacteriophage. My studies in Microbiology, Parasitology, and Immunochemistry have been mostly oriented toward the medical and public health aspects of organisms which cause human and animal diseases.

From 1960 to 1963, while a graduate student, I also held the full-time position of Optical Instructor/Optical Supervisor at the Adler Planetarium and Astronomical Museum, Chicago.

From 1958 to 1963 I was a Teaching Assistant and a Research Assistant in the Department of Microbiology, University of Illinois College of Medicine, Chicago.

During my professional career, not including my Master's and Doctor's Theses, I have published approximately a dozen papers in learned journals such as the Journal of Bacteriology, Mycopathologia, Journal of Parasitology, Journal of Cell Biology, and Applied Microbiology. I have also published several articles on optical technology. I have presented papers before the American Society for Microbiology, the Chicago Medical Mycological Society, the American Society of Parasitologists, the Society of Sigma Xi, the Illinois Society of Microbiologists, and others. In 1969, I invented a scientific device, assigned to Abbott Laboratories, Inc.

I am a member of the International Association for Great Lakes Research, the American Society for Microbiology, the American Society of Parasitologists, the Chicago Medical Mycological Society, and the Society of the Sigma Xi.

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RELATED CORRESPONDENCE

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	Docket Nos. STN 50-528
	)	STN 50-529
ARIZONA PUBLIC SERVICE COMPANY, et al.	)	STN 50-530
	)	
(Palo Verde Nuclear Generating Station, Units 1, 2 and 3)	)	INTERVENOR'S FIRST SET OF INTERROGATORIES TO JOINT APPLICANTS

INSTRUCTIONS

A. Unless otherwise indicated, information requested herein shall be for the time period beginning with the date of application for the construction permit through the expected life of the Plant.

B. In responding to these interrogatories, you may refer to the Final Safety Analysis Report and Environmental Report-Operating License Stage Report and other documents required by 10 C.F.R. § 51.1 et seq., where appropriate. However, these interrogatories seek information not included in such documents and it is expressly intended that the disclosure of such additional information be made.

C. Any pronoun shall mean the masculine, feminine or neuter gender, and singular or plural, as in each case may be appropriate.

D. Where knowledge or information in your possession is requested, such request includes knowledge of your agents, representatives, employees and, unless privileged, your attorneys; and

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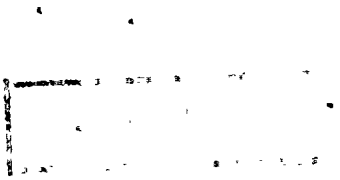

further, in answering these interrogatories, you are to furnish such information as is available to you, not merely information which is of your own knowledge. This means information known by or in the possession of your agents or employees, including your attorneys or any agents who have investigated such matter for you or your attorneys.

E. A space has been provided on the form of interrogatories for your answer. In the event that the space provided is not sufficient for your answer to any of the following questions, please attach a separate sheet of paper with the additional information.

F. These interrogatories shall be deemed continuing, requiring you to serve upon intervenor further and supplemental written answers, without notice or demand, promptly after acquiring further information with respect to the subject matter of any of these interrogatories.

DEFINITIONS

A. "A.T.W.S." shall mean anticipated transient without scram.

B. "C.E." shall mean Combustion Engineeing, Inc., of Windsor, Connecticut.

C. "Document" is used in its customary broad sense to include, without limitation, the following items, whether printed, recorded, filmed, reproduced by any process, written or produced by hand, and whether or not claimed to be privileged against discovery on any ground, and whether an original, master or copy: agreements, communications, including intracompany communications and correspondence; cablegrams, radiograms and telegrams; notes and memoranda; summaries, minutes and records of telephone conversations, meetings and conferences, including lists of persons attending meetings or conferences; summaries and records of personal conversations of interviews; books, manuals, publications and diaries; charts; plans; sketches and drawings; photographs; reports and/or summaries of investigations and/or surveys; opinions and reports of consultants; opinions of counsel; reports and summaries of negotiations; brochures; pamphlets; catalog and catalog sheets; drafts of original or preliminary notes on, and marginal comments appearing on, any documents; other reports and records; and any other information-containing paper, writing or physical thing in the possession, custody or control of the Joint Applicants.

D. "E.R.-O.L." shall mean Environmental Report-Operating License Stage.

E. "F.S.A.R." shall mean the Final Safety Analyis Report (operating license).

F. "N.R.C" shall mean the Nuclear Regulatory Commission.

G. "On site treatment facility" shall mean the sewage effluent treatment facility located at the Palo Verde Nuclear Generating Station.

H. "Person" or "persons" shall mean, without limitation, all entities including all predecessors in interest, individuals, associations, companies, partnerships, joint ventures, corporations, subsidiaries, trusts, estates, departments, bureaus, public agencies and boards.

I. "Plant" shall mean the Palo Verde Nuclear Generating Station, Units 1, 2 and 3.

J. "You" or "your" means the Joint Applicants, Arizona Public Service Company, Salt River Project Agricultural Improvement and Power District, Southern California Edison Company, El Paso Electric Company and Public Service Company of New Mexico.

K. "23rd Avenue facility" shall mean the sewage treatment facility operated by the City of Phoenix at 23rd Avenue.

L. "91st Avenue facility" shall mean the sewage treatment facility operated by the City of Phoenix at 91st Avenue.

CONTENTION NO. 1

1. Are radiation monitoring devices installed in the cooling towers? If so, please describe for each cooling tower where each device is located and describe each in detail.

2. Identify every document that supports or tends to support your answer to No. 1 above.

3. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 1 above.

4. Do any schools within a 25-mile radius of the Plant have radiation monitoring devices for gathering baseline data? If so, please identify the schools, give all data on frequency of reading each monitoring device and identify each person who does the reading and who has access to the devices.

5. Identify every document that supports or tends to support your answer to No. 4 above.

6. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 4 above.

7. What is the background radiation level at the Plant? What contribution do natural radioactive gases have in this level?

8. Identify every document that supports or tends to support your answer to No. 7 above.

9. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer

to No. 7 above.

10. In Curies, what is the anticipated inventory of radioactive gases contained inside the reactor? This information should be given for each reactor if differences in the inventories are anticipated.

11. Identify every document that supports or tends to support your answer to No. 10 above.

12. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 10. above.

13. In Curies, what is the anticipated inventory of radioactive gases contained in the rad-waste building of each reactor?

14. Identify every document that supports or tends to support your answer to No. 13 above.

15. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 13 above.

16. Describe the location and volume of release, in Curies, of all point sources of radiological gaseous effluents from all structures at each reactor. This information should include but not be limited to, a discussion of the height of any and all effluent stacks, their relative proximity to each other and a description of any mitigating filters.

17. Identify every document that supports or tends to support your answer to No. 16 above.

18. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 16 above.

19. Provide the information requested in Nos. 10, 13 and 16 above for each existing and operating C.E. reactor, including those reactors with less than one year operating experience.

20. Identify every document that supports or tends to support your answer to No. 19 above.

21. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 19 above.

22. Have you identified any existing radiological point sources in a 50-mile radius of the Plant? These would include

but not be limited to point sources of gaseous radioisotopes, aerosols, solids and liquids.

23. Identify every document that supports or tends to support your answer to No. 22 above.

24. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 22 above.

25. Identify all persons, to include their qualifications, who in any way authorized, devised, derived or formulated the recommendations and discussions contained in N.R.C. Regulatory Guide 1.109, Rev. 1.

26. Please identify all documents which were relied upon in developing N.R.C. Regulatory Guide 1.109, Rev. 1.

27. Identify all persons, to include their qualifications, who in any way authorized, devised, derived or formulated the GASPAR computer model.

28. Please identify all documents, to include mathematical working papers and computer programs (software) used in any way in connection with the GASPAR computer model.

29. In a fashion similar to that contained in Tables 5B-1 through 5B-7, Appendix 5B, E.R.-O.L., provide a detailed account of estimated individual doses (in millirems) from annual, historical, operating release of gaseous effluents from each existing and operating C.E. reactor, including those C.E. reactors with less than one year operating experience.

30. Identify every document that supports or tends to support your answer to No. 29 above.

31. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 29 above.

32. Describe all calculations, including but not limited to all mathematical working papers, computer printouts and other data, used to arrive at the individual dose estimates contained in Tables 5B-1 through 5B-7 of Appendix 5B of Sec. 5, Vol. IV of your E.R.-O.L.

33. Identify every document that supports or tends to support your answer to No. 32 above.

34. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 32 above.

35. What were the methods used to reach the calculations of individual dose estimates in the tables discussed in No. 32 above? Include any information which specifically addresses the names of these methods, their authors and their qualifications, computer models used to employ them and any other data.

36. Identify every document that supports or tends to support your answer to No. 35 above.

37. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 35 above.

38. What methods were used to verify compliance with Appendix I 10 C.F.R. § 50 and 40 C.F.R. § 190? Identify all persons, to include their qualifications, who in any way arrived at the claim of compliance.

39. Identify every document that supports or tends to support your answer to No. 38 above.

40. Identify all documents used for any calculations contained in Sec. 5 and its Appendices of your E.R.-O.L. pertaining to health physics.

41. Describe all topographical features, meteorological data, 50-mile radius population figures, local agricultural products including but not limited to all vegetables, citrus, dairy and meat operations, in a 50-mile radius for each operating C.E. reactor including those C.E. reactors with less than one year operating experience.

42. Identify every document that supports or tends to support your answer to No. 41 above.

43. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 41 above.

44. List all possible radiation food chain pathways.

45. Identify every document that supports or tends to support your answer to No. 44 above.

46. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 44 above.

47. With respect to each pathway identified in No. 44 above, please state the lengths in pathways in types of radioactive nuclides expected to enter such pathways.

48. Identify every document which supports or tends to support your answer to No. 47 above.

49. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 47 above.

50. Have you done any study or investigation to determine whether low level radioactive emissions from the Plant will have any genetic effects on the population, including the unborn, within a 50-mile radius of the Plant?

51. Identify every document that supports or tends to support your answer to No. 50 above.

52. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 50 above.

53. Have you done any study or investigation to determine whether low level radioactive emissions from the Plant may result in increases in deaths from cancer?

54. Identify every document that supports or tends to support your answer to No. 53 above.

55. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 53 above.

56. Identify all studies which you have done or done by local, state or federal governmental and non-governmental entities, of the individual dose estimates from the consumption of all citrus grown within a 50-mile radius of the Plant during normal operation of each reactor block. This information should include estimates based on the release of routine reactor gaseous effluents from the operation of Unit 1 or each reactor block and from the cumulative operation of all three reactors.

57. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 56 above.

58. What are the locations, production volumes, soil types, growing seasons and specific commodity(s) of all citrus operations within a 50-mile radius of the Plant? Identify these operations by the name or title of operating companies or individuals, their addresses and telephone numbers.

59. Identify every document that supports or tends to support your answer to No. 58 above.

60. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 58 above.

61. Identify all vegetable growing operations within a 50-mile radius of the Plant. This information should include but not be limited to the locations of such operations, the names and addresses and telephone numbers of all owners and/or operators of such operations, and the general topographical and soil property features of lands on which these operations are based.

62. Identify every document that supports or tends to support your answer to No. 61 above.

63. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 61 above.

64. Identify all animal producing operations within a 50-mile radius of the Plant. Animal producing operations is defined as any agricultural business which raises livestock for the purpose of sale to commodity markets for use as food for human consumption or any operation, however small, in which livestock is raised for eventual consumption by humans. This information should include the names, addresses and telephone numbers of all owners and operators of such animal producing operations; whether these feeds are grown

locally or processed elsewhere and imported; and all livestock operations to include beef, meat-packing, poultry, dairy, sheep, swine (pork) and any other designed for eventual human consumption.

65. Identify every document that supports or tends to support your answer to No. 64 above.

66. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 64 above.

67. Describe in detail each peice of equipment listed in Tables 5B 8 through 5B 11, Appendix 5B, E.R.-O.L. The description should include the names, addresses and telephone numbers of manufacturers of such equipment; how each piece of equipment operates; the manufacturer's sale price to the applicant; and any other information pertinent to understanding why such equipment would be necessary and how it works.

68. Please identify all documents which pertain to the requested information and which relate how such equipment has operated historically in other nuclear reactors.

69. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 68 above.

70. Explain all methods used in determining the cost benefit analysis in Sec. 5B.4, Appendix 5B, E.R.-O.L., including but not limited to, the historic evolution of cost benefit analysis whose goal is to "effect reduction in dose to the population reasonably expected to be within 50 miles of the reactor."

71. Please identify all documents pertaining to cost benefit analysis and any computer models and mathematical working papers used in arriving at the conclusion of Sec. 5B.4.

72. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 71 above.

73. What is the basis for the statement "the prevailing (wind) direction is from the east" contained in Sec. 2.3.1.1.3. of Vol. II of the F.S.A.R.?

74. Identify every document that supports or tends to support your answer to No. 73 above.

75. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 73 above.

76. What are the sources for Figs. 2.3.2 through 2.3. 14 in Sec. 2.3 of Vol. II of the F.S.A.R.?

77. Identify every document that supports or tends to support your answer to No. 76 above.

78. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 76 above.

79. Provide a detailed description of all studies pertaining to wind directions at the Plant site and to a 50-mile radius outside it that was not included in Sec. 2.3, Vol. II, F.S.A.R.

80. Identify every document that supports or tends to support your answer to No. 79 above.

81. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 79 above.

82. Describe in detail the names, types and specifications of all filters or any other mitigating equipment installed in gaseous release effluent stacks for each reactor block at the Plant.

83. Identify all documents relevant to determining the adequacy of such filters, including, but not limited to, manufacturers' names, addresses and telephone numbers; retail price of such equipment; and the historical use of such equipment in other operating reactors.

84. Identify all meteorological data available to you not contained in any filings in this case to date. Such information should include, but not be limited to, annual precipitation by month; monthly wind roses; ambient site termperatures on a monthly basis; and any information pertinent to local meteorological conditions.

85. Identify all commodity related agricultural operations within a 50-mile radius of the Plant. Such inventory should include, but not be limited to, all cotton growing operations; cottonseed oil production facilities; alfalfa or legume growing operations; wheat,

corn, soybeans, oats, flax, barley operations including flour milling facilities; and any other agricultural operation in which commodities are grown for ultimate use of consumption by humans. The inventory also should include the names, addresses and telephone numbers of the owners and operators of such facilities.

86. Identify every document that supports or tends to support your answer to No. 85 above.

86.a. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 85 above.

87. Provide a detailed description of the seasonal water flows in all surface-water systems within a 50-mile radius of the Plant. This information should include, but not be limited to:

A. The name and location of the water system;

B. All pertinent hydrologic and geologic information about such system;

C. The highest historical peak flow in each system;

D. The average non-peak flow of each system;

E. The average peak flow of each system;

F. In-flow rates from each system to underlying aquifers.

88. Identify every document that supports or tends to support your answer to No. 87 above.

89. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 87 above.

90. What are the local and regional underground water systems within a 50-mile radius of the Plant? Give their location, geology and lithology, in-flow rates from adjacent aquifers and surface waterways, water quality and any other pertinent information.

91. Identify every document that supports or tends to support your answer to No. 90 above.

92. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 90 above.

93. What drinking water and livestock watering wells have been identified within a 50-mile radius of the Plant? Please state the following information for each well:

A. Local geology including host aquifer;

B. Quality of waters from each well (to include a

reasonable description of various radiological and chemical constituents, including but not limited to, gross alpha, total radium, sulfates, TDS, TSS, conductivity, pH, etc.);

C. The names, addresses, telephone numbers of all persons who own or possess these wells or who receive waters from them.

94. Identify every document that supports or tends to support your answer to No. 93 above.

95. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 93 above.

96. What transport factors were used for uptake of radioactive isotopes, namely cesium, cobalt, strontium and plutonium into agricultural products, milk and meat?

97. Identify every document that supports or tends to support your answer to No. 96 above.

98. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 96 above.

99. Have you considered the effect of local and regional atmospheric temperature inversions in estimating the distribution of radioactive material emitted from the Plant? If so, please explain.

100. Identify every document that supports or tends to support your answer to No. 99 above.

101. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your

answer to No. 99 above.

CONTENTION NO. 5

102. What agreements or contracts exist with respect to assuring a supply of treated effluent for the Plant?

103. Identify every document that supports or tends to support your answer to No. 102 above.

104. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 102 above.

105. Assuming treated effluent would not be available for cooling purposes, what agreements or contracts exist with respect to assuring an alternative supply of water for such purposes?

106. Identify every document that supports or tends to support your answer to No. 105 above.

107. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 105 above.

108. Why did you chose to use sewage effluent to cool the Plant?

109. Identify every document that supports or tends to support your answer to No. 108 above.

110. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 108 above.

111. Are there any other nuclear plants in the United States operating or under construction, that use or will use sewage effluent for cooling purposes? If so, please state the name, location and M.W. rating.

112. Have there been any amendments or modifications to Agreement No. 13904, Option and Purchase of Effluent executed April 23, 1973? If so, please identify each amendment or modification.

113. Have any rights, claims, complaints or demands been asserted challenging the agreement referred to in No. 112 above, in whole or part? If so, please state:

A. The party asserting the claim;

B. The nature of the claim;

C. Your response to the claim.

114. Identify every document which supports or tends to support your answer to No. 113 above.

115. Have you entered into any agreements or contracts relating to disposal of sewage effluent? If so, please describe all such agreements.

116. Identify every document which supports or tends to support your answer to No. 115 above.

117. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 115 above.

118. Have you applied for C.A.P. water? If so, please state:

A. The quantity of water sought;

B. Projected date of delivery;

C. What impediments exist or might exist to prevent delivery;

D. Whether the water will require treatment of any kind;

E. For what period would you intend to receive C.A.P. water.

119. Identify every document which supports or tends to support your answer to No. 118 above.

120. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 118 above.

121. Do you plan to obtain effluent by means of tradeoffs for C.A.P. water? If so, please explain.

122. Identify every document which supports or tends to support your answer to No. 121 above.

123. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 121 above.

124. Describe the basic design for the 91st Avenue facility and the on site treatment facility.

125. Identify every document that supports or tends to support your answer to No. 124 above.

126. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 124 above.

127. Describe all treatment processes at the 91st Avenue facility and the on site treatment facility.

128. Identify every document that supports or tends to support your answer to No. 127 above.

129. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 127 above.

130. Please identify all blueprints of the on site treatment facility and the 91st Avenue facility to include connections between the 91st Avenue facility and the on site treatment facility and between the on site treatment facility and each unit.

131. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 130 above.

132. Has the 91st Avenue facility ever been the subject of any investigation, audit, complaint or lawsuit by any federal, state, county or other agency? If so, please state:

A. The agency making the investigation, audit, complaint or lawsuit;

B. The date;

C. The nature of the investigation;

D. The findings of the investigation;

E. The disposition of the investigation.

133. Identify every document that supports or tends to support your answer to No. 132 above.

134. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 132 above.

135. Describe the organization including functional organization of the on site treatment facility and the 91st Avenue facility.

136. Identify every document that supports or tends to support your answer to No. 135 above.

137. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 135 above.

138. Please identify each person with supervisory responsibility for the construction of the on site treatment facility.

139. With respect to the on site treatment facility, please identify each job category, description and qualifications, and N.R.C. technical specifications and/or guidelines regarding water quality.

140. With respect to the 91st Avenue facility identify each person who is an operator or technician.

141. How do you propose to transport the effluent from the 91st Avenue facility and the 23rd Avenue facility to the on site treatment facility?

142. Identify every document that supports or tends to support your answer to No. 141 above.

143. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 141 above.

144. Please describe the current stage of construction with respect to your answer to No. 141 above.

145. Identify every document that supports or tends to support your answer to No. 144 above.

146. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 144 above.

147. With respect to the 91st Avenue facility and the 23rd Avenue facility, for the past five years please state:

A. Annual flow records;

B. Each day's total minimum and maximum flow records.

148. Identify every document that supports or tends to support your answer to No. 147 above.

149. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 147 above.

150. Please provide projections of monthly peak flows from the 91st Avenue facility and the 23rd Avenue facility to the Plant and daily minimum and maximum flows. Show all calculations and specify any standards referenced and assumptions made.

151. Identify every document that supports or tends to support your answer to No. 150 above.

152. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 150 above.

153. What will be the monthly peak demand of McDonald farms and Roosevelt Irrigation District from the 23rd Avenue facility?

154. Identify every document that supports or tends to support your answer to No. 153 above.

155. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 153 above.

156. What will be the expected monthly peak demand of the Buckeye Irrigation District from the 91st Avenue facility?

157. Identify every document that supports or tends to support your answer to No. 156 above.

158. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 156 above.

159. If peak monthly demand will vary subsequent to the first full year of operation of all three units, please explain.

160. Identify every document that supports or tends to support your answer to 159 above.

161. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 159 above.

162. What is the peak monthly demand of treated effluent for each month of the first full year of operation of all three units?

163. Identify every document that supports or tends to support your answer to No. 162 above.

164. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 162 above.

165. Will there be any loss in treated effluent between the discharge from the treatment plants and delivery at the Plant? If so, what percentage of effluent available from the treatment plants will be lost?

166. Identify every document that supports or tends to support your answer to No. 165 above.

167. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 165 above.

168. What is the minimum acceptable effluent flow to the Plant assuimg the following:

A. Unit 1 is in service and operating at:

(1) 25% capacity
(2) 50% capacity
(3) 75% capacity

(4) 85% capacity

B. Units 1 and 2 are in service and both are operating at:

(1) 25% capacity

(2) 50% capacity

(3) 75% capacity

(4) 85% capacity

C. Units 1, 2 and 3 are in service and are operating at:

(1) 25% capacity

(2) 50% capacity

(3) 75% capacity

(4) 85% capacity

169. What will be the effect on delivery of effluent if the M.A.G. flow reduction programs in the Phoenix area are implemented to decrease sewer flow/water use?

170. Identify every document that supports or tends to support your answer to No. 169 above.

171. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 169 above.

172. What will be the effect on delivery of treated effluent if:

A. The 91st Avenue facility is not expanded any futher?

B. The 91st Avenue facility is not expanded on schedule?

173. Identify every document that supports or tends to support your answer to No. 172 above.

174. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 172 above.

175. Is each unit connected to the on site treatment facility independently?

176. Identify every document that supports or tends to support your answer to No. 175 above.

177. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 175 above.

178. Describe all of your requirements for effluent quality for the cooling of the Plant.

179. Identify every document that supports or tends to support your answer to No. 178 above.

180. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 178 above.

181. What testing, monitoring and analytical methods and procedures will be used to determine the quality of treated effluent? How often will such tests and monitoring be conducted?

182. Identify every document that supports or tends to support your answer to No. 181 above.

183. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 181 above.

184. Identify the content of iodine and salts in the sewage effluent before and after the treatment process at the on site treatment facility.

185. Identify every document that supports or tends to support your answer to No. 184 above.

186. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 184 above.

187. Also, what is the filter system for the on site treatment facility?

188. Identify every document that supports or tends to support your answer to No. 187 above.

189. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 187 above.

190. What amount of salts and iodine remains in the on site treatment facility after filtering?

191. Identify every document that supports or tends to support your answer to No. 190 above.

192. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 190 above.

193. What system will be used to treat sewage effluent at the on site treatment facility? Specify treatment system and equipment, capacity, processes used, supplies needed, personnel, training and supervision.

194. Identify every document that supports or tends to support your answer to No. 193 above.

195. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 193 above.

196. Please identify what water will be used for back-up in the event of system failures.

197. Identify every document that supports or tends to support your answer to No. 196 above.

198. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 196 above.

199. If the on site treatment plant cannot provide the quality of effluent required, what methods will mitigate the problem?

200. Identify every document that supports or tends to support your answer to No. 199 above.

201. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 199 above

202. Describe any and all licensing conditions and technical specifications of any regulatory or governmental authority which are related to operation of the on site treatment facility.

203. Identify every document that supports or tends to support your answer to No. 202 above.

204. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 202 above.

205. What amount of effluent from the 91st Avenue facility or the 23rd Avenue facility will be of unacceptable quality for cooling purposes?

206. Identify every document that supports or tends to support your answer to No. 205 above.

207. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 205 above.

208. Please describe what effect prolonged dependence on groundwater would have on the following:

A. Adjacent groundwater levels;

B. Adjacent groundwater quality;

C. Seismic activity in a 10-mile radius.

209. Identify every document that supports or tends to support your answer to No. 208 above.

210. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 208 above.

211. Please identify all documents determining projected seasonal variations with respect to sewage effluent quality.

212. If groundwater is to be used for back-up cooling purposes, what would be the long-term effect on the Plant of its prolonged use?

213. Identify every document that supports or tends to support your answer to No. 212 above.

214. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 212 above.

215. If any testing procedures at the 91st Avenue facility, deviate from applicable federal, state or county water quality or pollution control standards or regulations, provide complete justification and documentation for each deviation from standard methods.

216. Identify every document that supports or tends to support your answer to No. 215 above.

217. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 215 above.

218. Describe all waste and by-products from the treatment process expected at the on site treatment facility.

219. Identify every document that supports or tends to support your answer to No. 218 above.

220. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 218 above.

221. If prolonged dependence on groundwater becomes necessary, what effects have you calculated for subsidence?

222. Identify every document that supports or tends to suport your answer to No. 221 above.

223. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 221 above.

224. Describe the method and identify the location for disposal of each and every waste product from the on site facility.

225. Identify each document that supports or tends to support your answer to No. 224 above.

226. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 224 above.

CONTENTION NO. 6B

227. Please identify all documents relating to your estimates and probabilities of A.T.W.S. accident occurrence in C.E. reactors and compare such to N.R.C.'s postulated probabilities for C.E. plants.

228. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 227 above.

229. Please identify all documents pertaining to the latest methods for mitigating A.T.W.S. problems, to include all of your correspondence with any federal agency or consultant.

230. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 229 above.

231. Please identify all C.E. documents relating to A.T.W.S. testing and mitigation measures.

232. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 231 above.

233. For C.E. reactors in service, please identify each document pertaining in any manner to an analysis of A.T.W.S. accident probabilities.

234. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 233 above.

235. Please identify all N.R.C. and C.E. documents relating to failure of control rods to insert upon:

A. Manual command;

B. Automatic command.

236. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 235 above.

237. Please identify all documents relating to the history of System 80 control rod drive mechanism performance in all operating reactors in the United States.

238. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 236 above.

239. Please identify all documents relating to specifications of System 80 control rod drive mechanism design for all C.E. reactors.

240. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 239 above.

241. Please identify all documents relating to descriptions, and specifications, including cost data, on all pressurized water reactors which have installed new equipment designed to mitigate A.T.W.S. after completion of reactor construction.

242. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 241 above.

CONTENTION NO. 7

243. What is your estimate of the cost of decommissioning the Plant?

244. Identify every document that supports or tends to support your answer to No. 243 above.

245. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 243 above.

246. What method of decommissioning the Plant do you intend to use?

247. Identify every document that supports or tends to support your answer to No. 246 above.

248. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 246 above.

249. Why have you selected this method?

250. Identify every document which supports or tends to support your answer to No. 249.

251. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 249 above.

252. Provide the name, location and size in M.W. of any nuclear reactor ever decommissioned. What was the cost of decommissioning in each case? What was the initial estimated cost of decommissioning?

253. Identify every document that supports or tends to support your answer to No. 252 above.

254. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 252 above.

255. What is the N.R.C.'s estimate of decommissioning as a percentage of construction cost for a reactor of 1000 M.W. or more?

256. Identify every document that supports or tends to support your answer to No. 255 above.

257. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 255 above.

258. In what year, for each reactor do you anticipate decommissioning?

259. Identify every document that supports or tends to support your answer to No. 258 above.

260. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 258 above.

261. How do you plan to pay for the cost of decommissioning?

262. Identify every document that supports or tends to support your answer to No. 261 above.

263. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 258 above.

263. If the cost of decommissioning is to be passed on to the consumers receiving electricity from the Plant, how will you do this?

264. Identify every document that supports or tends to support your answer to No. 263 above.

265. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 263 above.

CONTENTION NO. 8

266. Assuming the base mats for Units 1 and 2 were not properly poured, please describe the accident possibilities which would result.

267. Identify every document that supports or tends to support your answer to No. 266 above.

268. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 266 above.

269. Please describe how the reactor system rests on the base mats on Units 1 and 2.

270. Identify every document that supports or tends to support your answer to No. 269 above.

271. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 269 above.

272. Where is the reactor cavity located in comparison to Units 1 and 2?

273. Identify every document that supports or tends to support your answer to No. 272 above.

274. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 272 above.

275. How much weight must the base mats for Units 1 and 2 hold?

276. Identify every document that supports or tends to support your answer to No. 275 above.

277. Identify every person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 275 above.

278. What is the foundation for Units 1 and 2?

279. Identify every document that supports or tends to support your answer to No. 278 above.

280. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 278 above.

281. Are there agreements or contracts between Bechtel Corp. and Engineering Testing Laboratory?

282. Identify every document that supports or tends to support your answer to No. 281 above.

283. Identify each person who knows of claims to have knowledge or information establishing or tending to establish your answer to No. 281 above.

284. Describe all safety reports and testing results made by Engineering Testing Laboratory with respect to the Plant.

285. Identify every document that supports or tends to support your answer to No. 284 above.

286. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 284 above.

287. Describe all concrete pouring test results during the period December, 1977 through March, 1981 with respect to the base mats for Units 1 and 2.

288. Identify every document that supports or tends to support your answer to No. 287 above.

289. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 287 above.

290. Please identify all structural engineers, field engineers, and supervisors who have worked for Bechtel Corp. and E.T.L. for the period December, 1977 through March, 1981 at the Plant.

291. ~~Identify every document that supports or tends to support your answer to No. 290 above.~~

292. Identify each ~~person who knows or claims to have knowledge or information establishing or tending to establish your~~ answer to No. 290 above.

293. Please identify all persons who performed slump tests for the base mats for Units 1 and 2 during the period of December, 1977 through March, 1981.

294. ~~Identify every document that supports or tends to support your answer to No. 293 above.~~

295. ~~Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 295 above.~~

296. Please describe how a concrete slump test is performed.

297. Identify every document that supports or tends to support your answer to No. 296 above.

298. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 296 above.

299. What are the specifications for the concrete for the base mats for Units 1 and 2?

300. Identify every document that supports or tends to support your answer to No. 299 above.

301 Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 299 above.

302. What specifications exist, if any, with respect to the cement which would be used in the base mats or with respect to the slump tests on the base mats either established by Bechtel, E.T.L. or the N.R.C.?

303. Identify every document that supports or tends to support your answer to No. 302 above.

304. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 302 above.

305. What are the stress requirements for the reinforced steel for the base mats for Units 1 and 2?

306. Identify every document that supports or tends to support your answer to No. 305 above.

307. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 305 above.

308. What specifications or regulations apply to the reinforced steel for the base mats for Units 1 and 2?

309. Identify every document that supports or tends to support your answer to No. 308 above.

310. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 308 above.

311. How much tritium gas (H^3) is released from each reactor block under normal operation for each year of operation?

312. Identify every document that supports or tends to support your answer to No. 311 above.

313. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 311 above.

314. From what piece of equipment, plant stack, or other point source is H^3 released.

315. Identify every document that supports or tends to support your answer to No. 314 above.

316. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 314 above.

317. What are the conditions under which H^3 is released?

318. Identify every document that supports or tends to support your answer to No. 317 above.

319. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 317 above.

320. Will routine releases of gaseous reactor effluents be regulated to achieve a constant release rate? If so, what is the rate?

321. Identify every document that supports or tends to support your answer to No. 320 above.

322. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 320 above.

323. If the answer to No. 320 above is no, are shorter releases of greater quantities of gaseous reactor effluents anticipated?

324. Identify every document that supports or tends to support your answer to No. 323 above.

325. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 323 above.

326. If the answer to No. 320 above is yes, are these short-term releases treated separately in dose calculations or included in averaged annual releases from which the dose calculations in Appendix 5B of E.R.-O.L. are derived?

327. Identify every document that supports or tends to support your answer to No. 326 above.

328. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 326 above.

329. What information has been gathered and what analyses have been made of exposure to short-term releases of gaseous radioeffluents in quantities greater than the annual average for the following:

A. Individuals (human);

B. Citrus nearing budding periods;

C. Food-animals during gestation periods;

D. Other plants grown for human consumption.

330. Identify every document that supports or tends to support your answer to No. 329 above.

331. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 330 above.

332. Are any radionuclides released during normal operating conditions not subject to infiltration or other contaminant-removal systems? If the answer is no, please state from which piece of equipment such releases occur, when and under what conditions such releases occur, and in what volume (in Curies).

333. Identify every document that supports or tends to support your answer to No. 332 above.

334. Identify each person who knows or claims to have knowledge or information establishing or tending to establish your answer to No. 332 above.

335. Do you intend to call witnesses in this proceeding? If so, with respect to each contention, identify each person you intend to call and for each state:

A. The witness's professional and educational background;

B. The nature of the witness's testimony, include a brief summary;

C. Identify all documents upon which the witness intends to rely, to include any research or study conducted by the witness, whether or not such studies will be relied upon.

336. With respect to each contention, please identify all documents which you have prepared in relation to or in connection with this proceeding.

337. To the extent not mentioned in No. 336 above, please identify all documents that you intend to rely upon in this proceeding.

338. Subsequent to the completion of the Draft Environmental Impact Statement, have you been requested by an agency of federal, state or local government to provide any documents or information relating to the Plant?

339. If so, for each request, please state the following:

A. The name of the agency and person requesting the information;

B. The date of the request;

C. A brief summary of the nature of the request;

D. A brief summary of your response;

E. The person submitting the response.

340. Identify each document that supports or tends to support your answer to No. 339 above.

341. Please identify all documents which you used to prepare the F.S.A.R. and the E.R.-O.L.

DATED this 22nd day of May, 1981.

Bruce J. Meyerson
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in the Public Interest
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Attorney for Intervenor

Copy of the foregoing hand-delivered this 22nd day of May, 1981, to:

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and mailed to:

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Washington, D.C. 20555

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