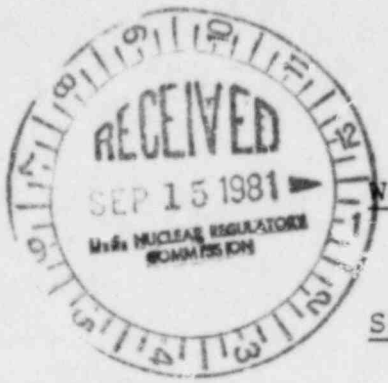

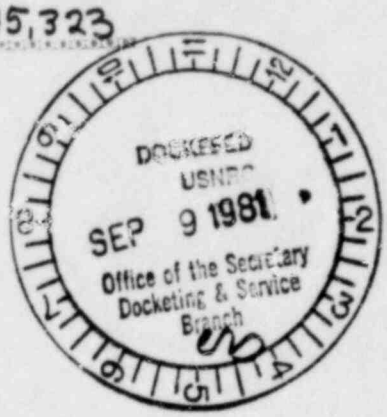

WRITTEN TESTIMONY

OF

SHELDON C. PLOTKIN

I. INTRODUCTION

My name is Sheldon C. Plotkin. I am president of Sheldon C. Plotkin & Associates, a Los Angeles consulting engineering firm. I received my Doctorate in Electrical Engineering from the University of California at Berkeley in 1956. Since then I have worked and written extensively in the fields of transportation and communications analysis, systems analysis and safety evaluation. In 1971 I formed Sheldon C. Plotkin & Associates. We perform accident and safety analyses, systems development and accident reconstruction, analyzing component failures and human factor dynamics, and the relationship between them.

My work experience includes applications of mathematical models to highway and vehicular systems. I have worked closely with highway and traffic engineers who have supplied information concerning applicable required specifications and recommended practices from the Traffic Department of the California Department of Transportation. In my work with highway and traffic engineers, I have performed the basic systems and safety analyses, relying on them only for the information concerning safety standards, as noted above. I have analyzed, for example, many multiple vehicular accidents, considering elements of highway design, driver performance, human factor response to accident conditions, etc. I have written a text on the subject, entitled Accident and Product Failure Analysis.

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My background includes development of a study on automated highways, advanced computer-controlled applications for automobile diagnosis, and numerous other systems and safety analysis projects. Attached to this testimony is a biography and partial list of publications, to be incorporated herein.

II. SUMMARY AND CONCLUSIONS

I have been asked to review the Applicants' and the local jurisdictions' plans for evacuation to determine whether, based upon my professional judgment as a systems safety engineer, the populations within the EPZ plume exposure pathway would be justified in believing that they were reasonably assured that adequate protective measures can and will be taken in the event of a radiological emergency. "Adequate protective measures" implies the choice of the protective measure which will protect the health and safety of the populations at risk. When the protective measure of choice is evacuation, there must be a reasonable expectation that evacuation will result in a so-called "dose savings," i.e., the populations at risk should receive significantly less radiation due to protective actions taken than they would if it were not taken. As has been stated in NUREG 0654, FEMA-REP-1, Rev. 1 at page 6, "The overall objective of emergency response plans is to provide dose savings (and in some cases immediate life saving) for a spectrum of accidents that could produce offsite doses in excess of Protective Action Guides (PAGs)." Based upon my analysis of the Applicants' Plan's time estimate for evacuation of a sector of the

plume exposure pathway EPZ under certain accident scenarios, I have concluded that under many possible accident scenarios for which persons responsible for choosing the appropriate protective measure might conclude that evacuation is the protective action of choice, evacuation would, in fact, expose the evacuating populations to unacceptable levels of radiation, causing injury and death.

10 CFR Part 50, Appendix E IV. requires the Applicant to submit plans which "provide an analysis of the time required to evacuate and for taking other protective actions for various sectors and distances within the plume exposure pathway EPZ for transient and permanent populations." As part of Applicants' Emergency Plan, such an analysis is included. It is the analysis of this time estimate which leads to my conclusion that populations for whom evacuation may be selected would not, in fact, be afforded dose savings, since they would be exposed to radiation far in excess of the PAGs.

The exposure of these populations to radiation in excess of the PAGs would come about, in part, due to flaws of the time study, the "Wilbur Smith Study," which will be detailed later. As is stated in NUREG 0654 , Appendix 4, p.4-1, it is important to provide (accurate) updated time estimates , "Because the evacuation time estimates will be used by those emergency response personnel charged with recommending and deciding on protective actions during an emergency..." It follows that decisions whether to evacuate or not will be as sound as the data upon which they are based. The Wilbur Smith Study which I have analyzed is seriously flawed, and cannot

be relied upon to produce accurate time estimates concerning the time required to evacuate the various populations of the plume exposure pathway EPZ. If relied upon for any serious accident in which it is important to have a reasonably accurate assessment of the time available for carrying out the appropriate protective action, it will result in serious and life threatening miscalculations ot the time available for taking such action.

III. ANALYTICAL APPROACH FOR DETERMINING CANCERS PER PERSON

A. Identification of Pertinent Parameters for Analysis

The Los Angeles Federation of Scientists Committee on Evacuation Time Study participated with me in studying the Wilbur Smith and Associates time estimates. We identified the following parameters for analysis of radiation effects:

1. Core inventory released
2. Wind speed
3. Wind direction.
4. Number of persons at risk
5. Volume of plume
6. Radioactivity of plume following release

b. Assumptions Made

This study group adopted certain assumptions, which are identified as follows:

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1. The plume was assumed to travel for one hour before its radiological effects were taken into account.
2. Radionuclides in the plume were assumed to be homogeneously distributed within it.
3. Evacuation was assumed to be constant at the exits from the EPZ plume exposure pathway.
4. A one per cent (1%) release of the core inventory was considered to be a representative serious accident.
5. A wind condition of a South East wind (SE) which creates a 22 1/2° plume of a relatively constant twenty meter (20 m.) height was assumed.

C. Results of the Study

Using the Wilbur Smith and Associates adverse weather time estimate for the evacuation of the Northern Sector, plume Exposure pathway EPZ, 6.25 hrs., we concluded that there would be 2.0 to 8.4 cancers per persons as a result of radiation exposure.

Using the Los Angeles Federation of Scientists' Worst case time estimate for the evacuation of the Northern Sector, plume exposure pathway EPZ of 28 hrs., we achieved a result of 9 to 35 cancers per person as a result of radiation exposure. The results of this study have caused me to conclude that even if the Wilbur Smith and Associates Study were cured of its flaws, there is no reason to expect that populations within the plume exposure pathway EPZ could be evacuated in time to prevent widespread injury and death from radiation under a large number of accident scenarios.

D. Methodology

To consider the effects of the above mentioned parameters on the health of the population at risk, we used the NRC's NUREG 0490 data for summarizing various atmospheric release categories representing hypothetical accidents at a PWR to calculate upper and lower bounds for radiological damage corresponding to release categories PWR 1 and PWR 9, respectively. The NRC worst case (PWR 1) gives releases that range from a high of 90% for noble gases to a low of 0.3% for the rare earths and for the related radionuclides. For the least case accidents (PWR 9) releases ranged from a high of 3×10^{-4} or 0.0003% to 0%.

Our calculated damage estimates for a 1% release (within NRC Categories PWR 1 - 9) are 178,700 to 3,127,250 total cancers among the 89,350 persons, all of whom were assumed to be adults, at risk in the plume exposure pathway EPZ. The intervening scenarios, including PWR 2 through PWR 8 releases, have been evaluated for only those radionuclides which make the most significant contributions to the overall radiological damage to the exposed population according to our uniform release scenario.

In our scenario, we considered the circumstances and results based upon a uniform release of 1% of the core inventory and calculated the corresponding radiological damage to the persons at risk of exposure in the EPZ plume exposure pathway. Our use of the 1% release figure is justified since it is well within the range of releases postulated in the NRC figures

for postulated releases ranging from PWR 1 through PWR 9.

In our 1% release scenario, we also worked out the damage that would result from three (3) different evacuation times. For all other variables except evacuation times, changes in radiological damage effect were directly or inversely proportional to the assumed values of the given parameters.

Our cancer estimates are based upon long term effects of exposures to radiation in large amounts over a relatively short period of exposure. A time frame of 50 years was used to permit the cancers to develop. Obviously, not all of the expected cancers will develop, since the very lethal ones will claim their hosts' lives before the subsequent ones can. Also, the long period of time will permit other intervening causes of death to prevent the actual development of cancer in some cases.

IV. A CRITIQUE OF THE WILBUR SMITH AND ASSOCIATES TIME ASSESSMENT

A. Inconsistencies with NUREG 0654 Appendix 4, p. 4-1

I have studied the Wilbur Smith study and the NUREG document just mentioned, and I have noted some ways in which the Wilbur Smith study does not meet the requirements of the NUREG guidelines, i.e., is inconsistent with it. A partial list follows, which I intend to supplement with a more complete list as an Exhibit.

1. NUREG 0654 Appendix 4, Section 1 part B requires that analyses of time assessments provide all assumptions used in the analysis. Only a partial statement is made.

2. NUREG 0654 requires that the analyses include a source for obtaining further data or documentation if computer models have been used. No such source is provided in the Wilbur Smith study.

B. Unsubstantiated Assumptions, Stated and Unstated in the Wilbur Smith Study. A brief list follows, which I shall supplement with an exhibit.

1. All vehicles in the plume exposure pathway EPZ have enough fuel to exit the EPZ.
2. No major roadway accidents will occur.
3. Spontaneous evacuation outside the area being evacuated will not materially interfere with evacuation.
4. Driver behaviors under conditions in which a threat to health is perceived will not have a negative impact on evacuation times.
5. No earthquake induced destruction of roadway networks has occurred.

V. A MORE REALISTIC APPROACH TO TIME ASSESSMENT USING A SYSTEMS ENGINEERING METHOD

Using a systems engineering method, and taking into account pertinent assumptions, a more realistic, and necessarily pessimistic time assessment for evacuation is obtained. The factors to be included in the system are:

1. Road network
2. Number of vehicles

3. Condition of vehicles

4. Human factors under adverse circumstances

5. Condition of roads

6. Population to be evacuated

7. Adverse weather

8. Occupants per vehicle

9. Highway failure modes.

I have examined a severe earthquake scenario, and an accident under adverse weather but without earthquake conditions, using a systems engineering approach. The earthquake scenario yielded a one week period for evacuating the entire Northern sector of the plume exposure pathway EPZ. The adverse weather senario without earthquake yielded a 28 hr. evacuation time estimate.

The extended evacuation times which would be necessary under many accident senarios plus the doses of radiation which would be contained in the plume exposure pathway EPZ would result in radiation injury and death of unprecedented magnitude in time of peace.

Biographical Data Re Sheldon C. Plotkin

Education

BSEE University of Colorado 1946
BS Aeronautical Engineering University of Colorado, 1949
PhD Electrical Engineering University of California at Berkeley, 1956

Professional Experience

Private consulting practice 1971 to present
RAND Corporation 1969-71 Santa Monica, Calif. Senior engineer in Engineering Sciences Dept., worked on various systems, including communication and transportation
TRW Systems 1967-69 Redondo Beach. Automatic Highway and high speed ground transportation development, large scale failure modes, automobile safety studies, train air suspension, civil system developments
Hughes Aircraft Company 1961-67 Staff engineer for G&C Advanced Systems Laboratoryand mathematics consultation department. Dynamic analyses, advanced control system design, communication system analyses, mathematical modeling, automobile systems development. (Originated infra red radar system concept for vehicle control.
University of Southern California 1958-61 Los Angeles Assistant Professor in charge of graduate and undergraduate electronics courses , redesign of electrical engineering labs.
Hoffman Electronics Corporation, 1959 to 1961 Consultant in Communications Systems Department
Energy Systems (Formerly Levinthal Electronic Products), 1956-58. Senior Project Engineer at Palo Alto for design and safety of high voltage, high power pulse modulators
University of California at Berkekey 1950-56. Teaching assistant 1950-54 in EE Dept. Project Engineer Cosmic Ray Lab in charge of equipment and operation
U.S. Naval Missile Test Center 1949-50 Point Magu Conduct and evaluation of missile tests as Aero and Electrical engineer
Los Alamos Scientific Laboratory 1946-47 New Mexico Design and construction of electronic material

Professional Affiliations

Registered Professional Safety Engineer, S.S.S., A.E.E.E., Pi Mu Epsilon, Eta Kappa Nu, Sigma Xi, Los Angeles Federation of Scientists.

Publications and Seminars

Several hundred papers, reports, and intra-company documents
Accident and Product Failure Analyses (book)
"Introduction to Accident, Safety and Forensic Engineering." (seminar)

Biography, continued

Military Service

Apprentice Seaman, U.S. Navy V-12 program, 1944-46
Lt. J.G. Naval Reserve (inactive) 1946 -approx 1953

Court Testimony

Vehicular accident reconstruction and design; slip and fall; human impact; electrical explosion; electronic circuitry; high voltage; escalator safety; elevator operation; highway design; pattern recognition; production equipment design and operation; human factor perception and dynamics.

Deposition and Reports

Fires; tire fabrication and design; test equipment; vehicle characteristics; criminal evidence.

PUBLICATIONS (Partial List)

"A Feasibility Study of High Power Magnetic Modulators," Final Report, Contract No. AF30(602)-1177, October 1956.

"Discontinuous Transition Time Between Stable States in Ferroresonant Circuits," Trans. AIEE Pt. 1 (Communication and Electronics), Vol. 76, pp. 410-421, September 1957.

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"A New Approach to Electrical Engineering Laboratories," Trans. IRE-PG on Education, Vol. E-4, No. 1, pp. 9-11, March 1961.

"On Limitations of Broad-Band Impedance Matching Without Transformers," Trans. IRE-PGCT, Vol. CT-9, No. 2, pp. 125-132, June 1962. Co-author Dr. N. Nahi.

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"On Nonlinear AGC," Proc. IRE (Correspondence), Vol. 51, p. 380, February 1963.

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"A Feasibility Study of Satellite Communication in the 15-20 Gc. Frequency Range," Report No. 4, Contract No. NASw-495, HRL, Malibu, Calif., January 1963. Co-author Dr. S. G. Lutz.

"Preliminary Study of Modulation Systems for Satellite Communication," Report No. 6R, Contract No. NASw-495, HRL, Malibu, Calif., June 1963.

"Preliminary Study of Compandors for Satellite Communication," informal report on Contract No. NASw-495, HRL, Malibu, Calif., May 1963.

"Some Overall Aspects of Automatic Checkout for Aerospace Systems," Proc. Systems Engineering Conf., N.Y., June 8-11, 1964. Co-authors R. H. Lauschner and Dr. V. Mayper, Jr.

"FM Bandwidth as a Function of Distortion and Modulation Index," IEEE Trans. on Com. Tech., Vol. COM-15, No. 3, pp. 467-470, June 1967.

"External Prison Security Study, Phase I," Final Report, State of Calif., Contract No. 1235, TRW, Redondo Beach, Calif., April 1968.

"Automation of the Highways, An Overview," IEEE Trans. on Veh. Tech., VT-18, August 1969.