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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
METROPOLITAN EDISON COMPANY	)	Docket No. 50-289
	)	(Restart)
(Three Mile Island Nuclear Station, Unit No. 1)	)	

LICENSEE'S TESTIMONY OF MILTON LEVENSON ON
REALISTIC ESTIMATES OF THE CONSEQUENCES OF
NUCLEAR ACCIDENTS FOR USE IN EMERGENCY PLANNING

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OUTLINE

This testimony summarizes the findings and conclusions presented in the paper by Levenson and Rahn on "Realistic Estimates of the Consequences of Nuclear Accidents"; the paper is attached to, and is a part of, the testimony. Mr. Levenson concludes that a broad range of natural phenomena, including gravity, aerosol physics, chemical solubility, chemical reactivity, physical plate out and adsorption, act to significantly reduce the amount of radioactivity released to the public environment during a nuclear power plant accident. These phenomena have not been treated properly in previous analyses of reactor accident consequences, and, as a result, such analyses significantly overestimate the release of radioactivity during an accident. For emergency planning purposes, Mr. Levenson's testimony provides assurance that the NRC's new emergency planning rule provides substantial conservatism with respect to the distances out to which preplanning should be done and the times within which accident recognition, notification and assessment, as well as protective actions, need take place.

LICENSEE'S TESTIMONY OF MILTON LEVENSON ON REALISTIC ESTIMATES OF THE CONSEQUENCES OF NUCLEAR ACCIDENTS FOR USE IN EMERGENCY PLANNING

My name is Milton Levenson. I am currently employed by the Bechtel Power Corporation, 50 Beale Street, San Francisco, California. As a professional engineer I have been directly involved in nuclear research, reactor design and operation, and safety reviews and assessments for over 37 years. This experience includes not only research and development and work in routine matters, but also includes direct involvement in the post-accident period of both the SL-1 accident and the TMI-2 accident. At TMI-2, I was in charge of the group called the Industry Advisory Group ("IRG"). This group included knowledgeable, experienced people from universities, reactor vendors, architect/engineering firms, and research organizations. Our job was to provide a real-time, on-site independent assessment of all actions taken or to be taken between the day of the accident and the time that the plant was placed on natural convection cooling approximately one month later. As chairman of the IRG, I or my deputy attended the semi-daily or daily meetings between NRC, GPU/Metropolitan Edison and Babcock & Wilcox to make sure we were aware of what was being done and what was being planned.

The Licensee has requested that I summarize the conclusions of the paper on "Realistic Estimates of the Consequences of Nuclear Accidents" (attached to this testimony as Appendix A) that I co-authored with Dr. Frank Rahn when I was at the Electric Power Research Institute ("EPRI"). My testimony also summarizes the events which preceded the paper (and provided the impetus

for our further thinking in this area), the events that have transpired since the first distribution of this paper in September 1980, and the implications of the conclusions drawn in the paper for emergency planning at TMI. The purpose of this discussion is not to downgrade the usefulness of emergency planning at a fixed nuclear power plant, but rather to place such planning in a realistic context and to suggest, at least qualitatively, the conservatism associated with current efforts to upgrade emergency planning at commercial nuclear power plants.

The basic conclusions of the paper are that all previous light water reactor risk assessments examined, including WASH-1400, had either treated inadequately or not at all a significant number of scientific and technical phenomena; that these phenomena assured that in all cases the actual release of radioactivity to the public environment was less by orders of magnitude than was being estimated in the risk assessments. The paper does not address the probability of accidents nor the dispersion phenomena of what is released. It addresses the natural attenuating phenomena that reduce to a very, very small fraction of what might actually leave the fuel (even if that fuel is molten) the amount of airborne radioactivity that reaches the outside environs of a nuclear power plant. Another way of stating the conclusions is that even in the very remote case of a reactor accident that proceeds to fuel melting and concurrent loss of containment integrity, large fraction releases of radioactivity to the public environment will not occur for any elements other than krypton and xenon.

Last spring, the ongoing and planned research in the field of risk assessment was reviewed as a part of the EPRI program planning activity. It became apparent that there was little correlation between consequences being used in risk assessment and the actual results of either accidents or large scale experiments. It also became apparent that while there had been peer review of the probability half of the risk model, there had been no in-depth peer review of the consequence half of the model. We therefore started to question why what was actually occurring was always so much less than calculated. The answer, as discussed in the paper, was that various attenuation (or trapping) phenomena were not being properly taken into account.

The NRC requested a briefing on this subject on November 18, 1980, and requested that the Office of Nuclear Regulatory Research reassess their current position. The Presidential Nuclear Safety Oversight Committee ("NSOC") requested that it be briefed on December 16, 1980, and sent a letter to President Carter identifying this subject as a matter of some substance. I participated in both those briefings. At the same time, other technical groups have also been reviewing this issue. In addition to our paper, other papers on various phases of this issue were presented at the 1980 joint American Nuclear Society/European Nuclear Society meeting in Washington, D.C. Each of these other papers contributes information that supports our basic conclusion. These eight papers are being published in a special issue of Nuclear Technology to be issued in May 1981. Attached to this testimony as Appendix B is the introductory "Perspective" that I was requested to prepare for that issue.

The conclusions presented in our paper are not based on a single phenomenon nor on a single unique set of circumstances. The phenomena include gravity, basic aerosol physics, chemical solubility, chemical reactivity, physical plate out, and adsorption.

These natural phenomena have been most often discussed in terms of iodine. Elemental iodine is extremely reactive, and in reducing conditions, such as the presence of hydrogen and zirconium, is probably present as cesium iodide. If fuel temperature could rise above the decomposition point of cesium iodide, one can postulate that both cesium and iodine might be volatilized from the fuel. However, the elemental species would travel only inches before the temperature would start to drop drastically and they would therefore recombine. Even if this process did not occur, the condensed material would impact pressure vessel internals and pipe walls with attendant retention before it exited from the primary system. The material that did exit would be in a wet steamy space with wet walls, pipes, valves, railings, gratings and hundreds of tons of miscellaneous steel and concrete items. At every contact with any surface and at the surface of every falling drop of water, some of the radioactivity is immobilized by reaction, solubility or adsorption. Exactly how much is removed at each step by which phenomena will of course vary for each scenario, but the total removal is always large and should not be ignored.

This analysis of natural phenomena that would reduce the release of radioiodine to the environment is just an example. Similar mechanisms apply for all other fission products,

including cesium, tellurium and ruthenium. There is no question about these phenomena being operational at all times. There is no question that when operational they reduce the amount of radioactivity released to the environment. The only question is precisely how large has been the overestimate. It is not my objective to quantitatively resolve that question here, but only to point out that the current estimates of release to the public environment are higher than can really occur.

It should be noted that there are really no preconditions for this all to occur. The integrity of the containment building may have a large effect on the amount of noble gases released to the public environment, but the chemical and physical attenuation of all other elements occurs whether the containment building has or has not retained its integrity. These phenomena were observed in the SL-1 accident where there was no containment building.

Nor do any of these phenomena require the existence or functioning of any engineered safeguards features of the plant. Any introduction of water by ECCS systems (or makeup systems, or purge systems, or cleanup systems), any functioning of building spray systems, any operation of reactor building cooling systems, result in further reduction in the amount of radioactive material available for release.

While we have attempted to address the question of what this means in a quantitative way -- are WASH-1400 results high by a factor 100, 1,000, 10,000 -- there is no single answer because neither WASH-1400 nor any of the other major studies

has single scenarios. All that we can say is that the overestimates appear to be universal; they include all elements (except xenon and krypton) and all cases. In some scenarios the estimate may be high by 100 for one element and by 10,000 for another element, while in another scenario they are both high by 1,000.

The TMI-2 accident is a very important benchmark as something that really happened, as opposed to a computer calculation. The reactor compartment and the steam generator shields contain tons of concrete and steel and its associated heat capacity and surface. The miles of pipe and conduit and handrails and platforms provide large amounts of additional surface area for plate out, condensation, adsorption and chemical reaction. A review of the drawings for the TMI-1 reactor building indicates structures similar to those at TMI-2, and, therefore, in the event of an accident at TMI-1 the same overall effect will be present: a large attenuation in the amount of radioactivity released to the environment.

An important observation very early in our assessment was that even the minimum expected attenuations had very large effects in terms of times and distances relative to emergency planning, and on the real potential effects on public health. Ian Wall,* one of the principal authors of WASH-1400, has estimated that a reduction of only 10 in the source term means no acute deaths. It means that for a member of the public to receive the dose that previously was calculated for a one-hour

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*/ From testimony to NRC on November 18, 1980.

exposure now requires more than 10 hours -- in fact, more, because the source is decaying fairly rapidly in these short times. It also means that the threatened distances are reduced in a similar fashion. While one can postulate a wide range of scenarios and conditions, it would appear that the technical evidence would indicate no required evacuation before a period of hours after the start of an accident and no need to evacuate people beyond a few miles, with perhaps an outside limit of five miles. In addition, as the noble gases become a larger and larger fraction of the source term, sheltering becomes a more and more effective protective action.

It is now nine months since we first distributed copies of our paper for comment. Over 500 people have requested copies. It was discussed with the Advisory Committee on Reactor Safeguards ("ACRS"), in addition to the NRC. It is being discussed abroad as well as in the United States. It has generated a great deal of controversy, but none of it relates to whether there are or are not large conservatisms in existing assessments. The controversy is only one of how big has been the overestimate.

APPENDIX A

REALISTIC ESTIMATES OF THE CONSEQUENCES OF NUCLEAR ACCIDENTS

by

M. Levenson* and F. Rahn
The Electric Power Research Institute
Palo Alto, California 94303

, 1980

*Now with Bechtel Power Corp., San Francisco, CA