UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
COMMONWEALTH EDISON COMPANY	)	Docket Nos. 50-545 OL
	)	50-455 OL
(Byron Nuclear Power Station, Units 1 & 2)	)	

SUMMARY OF TESTIMONY OF
GEORGE C. KLOPP CONCERNING
CONSOLIDATED CONTENTIONS 39 AND 109

Mr Klopp is a General Design Engineer employed by Commonwealth Edison Company. Mr. Klopp has considerable expertise in the field of probabilistic risk assessment of nuclear power plant accidents. His testimony addresses the likelihood of a core melt accident which would lead to significant releases of radioactive contaminants to the groundwater.

Mr. Klopp first discusses the reasons why, in his opinion, a core melt event with total penetration of the containment basemat is extremely improbable. He then sets forth the basis for his opinion why the NRC Staff conclusion that the risk of releases to the groundwater associated with core melt events are "small" is very conservative. Mr. Klopp finally explains that because of the extreme improbability of the core melt/basemat penetration event, the overall conclusion regarding the liquid pathway risk is not very

sensitive to uncertainties regarding the transit time of contaminants through the groundwater.

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TESTIMONY OF GEORGE KLOPP CONCERNING
CONSOLIDATED CONTENTIONS 39 AND 109

Q.1. Please state your name, present occupation and present position.

A.1. My name is George Klopp. I'm a General Design Engineer in Commonwealth Edison's Station Nuclear Engineering Department.

Q.2. Briefly state you educational and professional qualifications.

A.2. In 1964, I received a B.S.M.E. and in 1965 I received an M.S.M.E. (nuclear option) from the University of Kentucky. I have been with Commonwealth Edison since 1965, except for a two year military leave of absence, and I have been involved in engineering, operation, engineering management, and safety analysis relating to nuclear plants for my entire career.

Q.3. Describe your current duties and responsibilities with Commonwealth Edison.

A.3. At this time, I have a number of responsibilities. They include: (1) Technical Director of Edison's Zion Probabilistic Safety Study (PSS) since 1979. My responsibilities in this capacity include participating in the development of new techniques employed to model containment effects, performing certain calculations, coordinating the work of various consultants assisting the company in this study, participating in the review of the study and controlling the schedule and budget for the project. Since the PSS has been submitted to the NRC, my ongoing responsibilities have included licensing activities, training Edison personnel with respect to the study, and evaluations of the need for power plant design modifications and changes to operating procedures related to the Zion PSS. (2) Lead engineer for Edison's technical participation in the Industry Degraded Core Program (IDCOR). (3) Technical director for the Byron Risk Study. My responsibilities included establishing scope and methodology of the study, reviewing study calculations, performing verification calculations, participating in report writing and conducting a review of the report with senior engineers at Westinghouse

Electric Co. (4) Acted as Edison's representative to the technical writing group of the industry/NRC Probabilistic Risk Assessment Procedures Guide Program. (5) Acted as technical adviser on the Clinch River Breeder reactor plant probabilistic risk assessment program. (6) Acted as Edison's representative to the Department of Energy Working Group on Probabilistic Risk Assessment. (7) Acting as pressurized water reactor technical adviser to Edison's Generating Stations Emergency Plan program. (8) Acting as a technical adviser to other groups or departments within Edison on matters related to nuclear safety, risk assessment and degraded core phenomenology. (9) In October, 1982, I also become responsible for licensing, pre-operational test review and NSSS management for Byron and Braidwood reporting directly to the Director of Engineering for those plants.

Q.4. What other assignments have you held at Commonwealth Edison Company?

A.4. My earlier assignments with the Company included: (1) Acting as lead Nuclear Engineer, in Edison's Engineering Department, for the Zion Station project during design, construction and initial start-up. (2) Acting as the Project Engineer for the first two

years of the Byron Braidwood Project Development. (3) Serving as an Operating Engineer in the radioactive waste disposal area at the Dresden Station. (4) Serving as a Project Engineer for the Station Nuclear Engineering Departments Reliability and Design Engineering Group.

Q.5. Have you written any articles in professional engineering journals?

A.5. Yes. I have written an article entitled "Highlights of the Zion Probabilistic Safety Study" which appeared in the January 1982 edition of "Power Engineering." This article traced the basic principles employed in the Zion Study, enumerated new techniques used and presented the study findings.

Q.6. What is the scope of your testimony?

A.6. My testimony addresses certain of the issues raised by Consolidated Contentions 39 and 109. Those contentions, together with explanatory material supplied by the intervenors during discovery, assert that the consequences of radionuclide release to the underlying aquifer cannot be predicted with confidence and, accordingly, that required findings under the Atomic Energy Act and NEPA cannot be made. My

testimony analyzes such a radionuclide release following a large-scale accident (containment basemat penetration) in the context of the likelihood of such an event occurring. I discuss whether the safety regulations of the NRC require such an analysis and whether the subject is treated appropriately in the Byron FES.

Q.7. Please describe the basis for the professional engineering opinion which appear subsequently in your testimony.

A.7. The opinions expressed in this testimony are based on my study of WASH-1400, my work on the Zion PSS and the IDCOR program and my work on and results of the Byron Risk Study.

Q.8. Is penetration of the containment basemat and subsequent release of radioactive material in the underlying ground water analyzed in the Byron FSAR.

A.8. No.

Q.9. Why was such an analysis not made in the Byron FSAR?

A.9. Such an analysis presupposes that a full core melt and subsequent penetration of the reactor vessel by molten core material has occurred. The FSAR does not analyze events involving full core melts.

Q.10. Why is this the case?

A.10. The FSAR accident analyses are performed in accordance with all the requirements imposed by NRC regulations, regulatory guides and standard review plans. As such, they evaluate a wide spectrum of accidents ranging from those involving routine operating transients to those involving design basis accidents such as a large loss-of-coolant accident. The FSAR does not analyze accidents beyond the design basis such as full core melts because these events are deemed to be sufficiently improbable and because regulatory requirements for such analyses in the FSAR do not exist. It has been an NRC policy recently reiterated by the Commissioners that such events need not be considered in the context of individual safety proceedings.

Q.11. What protections are provided in the design of the Byron Station to minimize the likelihood of a core melt event and to prevent ground water contamination following a core melt accident?

A.11. Groundwater contamination as a consequence of a core melt accident can occur only as a result of penetration of the underlying concrete and steel basemat by molten core debris. This penetration would occur as a result of continued ablation of the

basemat by high temperature core debris. The probability of this penetration is very small due primarily to design features which reduce the probability of a core melt occurring in the first place to a very small value. These features include the ECCS, the instrumentation and protection logic systems, the basic structure of the primary auxiliary systems themselves and the redundancy of critical support systems. Secondly, the design of the Byron containment systems is such that even should a core melt occur, basemat penetration will occur only in the severest of accidents. This further reduces the probability of such an event.

In the event of a core melt which proceeds to vessel failure, this failure is predicted to occur at the instrumentation penetrations in the vessel lower head. Upon failure the core debris will be dispersed over the floor of the reactor cavity area of containment and, in most cases, over the upper basemat area. The reactor cavity at Byron is the low point of the containment. Because of this design feature, water which collects on the basemat from the operation of containment sprays and primary system leakage spills readily into the reactor cavity. This cavity water will quench the core

debris to a temperature below that required for concrete ablation preventing basemat penetration. The continued presence of water resulting from spray or fan cooler operation prevents reheating of the core debris.

In cases where no cavity water is present (i.e., failure of containment sprays and fan coolers), concrete ablation occurs at a relatively slow rate such that time is available to procure an alternate source of water or restore existing systems.

Q.12. How has the risk of groundwater contamination following coremelt accidents been characterized in the Byron FES?

A.12. The risk of groundwater contamination following a postulated core melt accident is one of several impacts from severe accidents which are analyzed in Chapter 5 of the FES. The NRC's overall conclusion regarding all such severe accidents is that their "impacts could be severe but the likelihood of their occurrence is judged to be small". These conclusions regarding overall accident risk including risk of groundwater contamination following a postulated core melt accident are further refined by the NRC in its Table 6.1 Benefit-Cost Summary in which human

health effects due to accident risk are characterized as having a "small" impact. The word "small" is defined as "impacts which in the reviewer's judgment are of such minor nature . . . that they do not warrant detailed investigations or considerations of mitigating actions . . . ."

The Byron FES has treated releases of radioactivity to groundwater and has shown the doses to be a very small fraction of those that can arise from atmosphere pathways. In this study, which used NUREG-0440, "Liquid Pathway Generic Study", as a guide, a number of conservative assumptions were used to estimate the timing and magnitude of ground water contamination. In the Byron FES calculation of ground water contamination, it was assumed that upon basemat failure, water from the containment would be available to transport radionuclides quickly to ground water sources. More recent analysis has shown that for the cases in which basemat failure is predicted at Byron no containment water will be present. This has the effect of decreasing both the timing and magnitude of radionuclide releases.

Q.13. Do you have a professional opinion as to the validity and accuracy of the FES characterization of the risk to the population arising from an accident resulting in containment basemat penetration?

A.13. Yes. The Byron FES characterization of liquid pathways risk is in my judgment very significantly conservative. Some of the major areas of conservatism are: (1) The Byron FES assumes that each and every postulated core melt event results in containment basemat failure with subsequent groundwater release. In my judgment, the vast majority of postulated core melt events would not result in containment basemat failure. (2) The source term employed in the Byron FES is based on the assumption that two mechanisms exist for transporting radioactive material to the groundwater. The dominant mechanism involves the release of what is called sump water which would be highly contaminated by core debris material. This source term contribution is 100 to 1,000 times greater than the second mechanism which involves leaching of radioactive material from the debris once the core debris is in contact with groundwater. At Byron the sump water source term can be eliminated since basemat penetration will not occur coincident with the presence of significant sump water. Therefore, the

FES source term is a factor of 100 to 1,000 too high.

Q.14. What is the basis for your opinion regarding the conservatism of the FES calculation of the risk from groundwater contamination following containment basemat penetration.

A.14. The basis for my judgment rests on detailed calculational work done for the Zion Probabilistic Safety Study, the Indian Point Probabilistic Safety Study, the Byron risk study and ongoing programs under the auspices of the IDCOR program. These efforts have been cross-calibrated in detail with the results of wide variety of experimental programs both here and abroad. The basic conclusion from this work which results in the judgments I have just rendered is that molten core debris will be coolable even outside the reactor vessel provided that an adequate supply of water is available to quench the debris and that heat removal mechanisms such as containment sprays or containment fan coolers are operational. Clearly then to have basemat penetration, one must postulate that the water needed to cool the debris is absent. With that water being absent, no sump water source term can exist. Even if the quench water is absent and basemat concrete attack is

evaluated, the period of time available before basemat penetration is complete ranges from eight hours to days. This time period would allow margin for recovery actions that would involve adding water to the debris and restoring the operation of heat removal systems.

Q.15. Do you agree with the FES conclusion that the risk from severe accidents at Byron is small and that the contribution to that small residual risk from liquid pathways is very small?

A.15. Yes, I do. The work that we have done and which I have cited in response to a previous question, indicates that the FES in general presents a very conservative representation of the risk from Byron and for the reasons noted in response to the previous question, I clearly agree that liquid pathways represent an insignificant fraction of that small residual risk.

Q.16. How important, then, is the potential sensitivity of groundwater risk to uncertainties in the groundwater transit time?

A.16. Clearly it is not important. The probability of basemat penetration is very low and the source term available is far lower than has been previously

estimated. The Byron FES results show that liquid pathways risk is not significant. It may be argued that the transit time used in the FES are too long or too short or too uncertain but such effects are insignificant given the fact that the FES source terms was a factor of 100 to 1,000 more severe than is appropriate for Byron.