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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

OFFICE OF SECRETARY DOCKETING & SERVICE BRANCH

Before the Atomic Safety and Licensing Board

In the Matter of	)	
	)	
THE CLEVELAND ELECTRIC	)	Docket Nos. 50-440 OL
ILLUMINATING CO. ET AL.	)	50-441 OL
	)	
(Perry Nuclear Power Plant,	)	
Units 1 and 2)	)	

MOTION TO COMPEL THE APPEARANCE OF DR. MARSHALL BERMAN

I. Introduction

Intervenor Ohio Citizens for Responsible Energy ("OCRE") hereby moves the Licensing Board to compel the appearance and testimony at the evidentiary hearing of Dr. Marshall Berman, supervisor of the Reactor Safety Studies Division of the Sandia National Laboratory, Albuquerque, NM. OCRE requests that Dr. Berman appear as a Staff witness and present testimony addressing experimental and analytical efforts at Sandia concerning the generation, combustion, and control of hydrogen in degraded core accidents and the threat to containment integrity posed by hydrogen. These matters are relevant and material to Issue #8, on hydrogen control, in this proceeding.

Specifically, Dr. Berman should present testimony on the findings and conclusions resulting from the research program

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described in Section III below, especially that concerning hydrogen deflagration characteristics; detonations, flame acceleration, and deflagration-to-detonation transition; analytical efforts concerning MARCH, HECTR, and HYBER; and Sandia analyses and assessments of Mark III hydrogen control, including the distributed igniter system, the CLASIX-3 deflagration code, and continuous diffusion flames, and the effects of Mark III hydrogen combustion on containment integrity and equipment survival. Dr. Berman should be available for liberal cross-examination on these matters as well.

II. The Standards for Compelling the Appearance of a Staff Consultant

According to 10 CFR 2.4(p), Dr. Berman, as an employee of Sandia, which is a NRC contractor, is, for the purposes of 10 CFR 2.720, to be classified as "NRC personnel." (1) 10 CFR 2.(h)(2)(i) states that

> the attendance and testimony of the Commissioners and named NRC personnel at a hearing or on deposition may not be requireaby the presiding officer, bysubpoena or otherwise, provided that the presiding officer may, upon a showing of exceptional circumstances, such as a case in which a particular named NRC employee has direct personal knowledge of a material fact not known to the witnesses made available by the Executive Director for Operations require the attendance and testimony of named NRC personnel.

The Appeal Board in Metropolitan Edison (Three Mile Island,

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(1) It should be noted that 10 CFR 2.4(p) was promulgated (38 Fed. Reg. 1500, January 15, 1973) contrary to the notice and comment requirements of the Administrative Procedure Act, 5 USC 553, and in effect reversed the reasoned decision of the Appeal Board in Wisconsin Electric Power Company (Point Beach, Unit 2), ALAB-63, 5 AEC 269 (1972), which held that employees of the National Laboratories are not agency personnel and are freely subject to subpoena.

Unit 1), ALAB-715, 17 NRC 102 (1983) stated that, since a genuine scientific disagreement on a central decisional issue is the type of matter that should be raised for adversial exploration and resolution in the adjudicatory context, compelling the appearance of NRC personnel holding different views on such an issue is necessary. This situation is another example of "exceptional circumstances."

Both examples of "exceptional circumstances" are present here. OCRE has ascertained, through a conversation with Staff counsel, that the Staff does not intend to present Dr. Berman (or anyone else from Sandia) at the hearing on Issue #8. The Sandia Reactor Safety Studies Division, under Dr. Berman's direction, has conducted extensive experimental research on hydrogen combustion and control. Much of this work is ongoing. (This research is described in greater detail below.) Since the Staff does not conduct its own research on these matters, it is likely that the Staff witnesses do not have all the facts in Dr. Berman's possession.

Sandia has also conducted analytical studies of hydrogen control in the Grand Gulf Mark III containment. This study (NUREG/CR-2530) demonstrated the non-conservative nature of the CLASIX-3 computer code, relied upon by Applicants in their preliminary analysis filed with the NRC on March 1, 1985, and the marginal nature of the distributed igniter system at Grand Gulf, conceded by Applicants to be virtually identical to

Perry's.

Sandia's analyses of Grand Gulf result in part because the NRC Staff sought Sandia's technical assistance in evaluating the Grand Gulf hydrogen control system. The Staff "summarized" Sandia's findings in Grand Gulf SSER 3 (NUREG-0831). "Mischaracterized" might be a better term, as the Staff expressly rejected Sandia's finding that the igniter concept is marginal, and claimed that Sandia's analysis supported the Staff's interim approval of the system. See Exhibit 1. There thus exists a genuine scientific disagreement on a central issue, which, according to ALAB-715, constitutes exceptional circumstances for compelling the appearance of Dr. Berman.

A similar situation occurred in the McGuire OL hearings on hydrogen control. There Dr. Berman testified at the request of the Licensing Board because Sandia's evaluation of the Sequoyah plant, an ice condenser like McGuire, revealed dangers in the use of the distributed igniter system not considered by the Staff. The Staff had not planned to present Dr. Berman. See the McGuire OL Transcript at 3270. Exceptional circumstances therefore exist in this proceeding as well.

For the Board's information, OCRE has attached as Exhibit 2 a copy of Dr. Berman's professional qualifications, taken from the McGuire transcript (1981).

III. A Summary of Sandia Hydrogen Research

To illustrate the great expertise accumulated by Sandia in the area of hydrogen generation, combustion, and control, OCRE will summarize herein the experimental and analytical research conducted by Sandia.

A. Experimental Research

Sandia is the prime contractor for five NRC-sponsored research programs on hydrogen. These are the Combustible Gas in Containment Program, concerning the rates and amounts of hydrogen generated by corrosion of coatings in the containment during reactor accidents; the Hydrogen Burn Survival Program, to evaluate the response of safety-related equipment to the severe environments resulting from hydrogen combustion; the Code Assessment and Application Program, which has evalyated the German hydrogen transport code, RALOC; the Hydrogen Combustion Mitigative and Preventive Schemes Program, which has evaluated a number of hydrogen control methods; and the Hydrogen Behavior Program, which emphasizes hydrogen aspects.

It should be noted that the purpose of these programs is to answer urgent licensing questions. NUREG/CP-0038 at 46.

Experiments concerning hydrogen deflagration have been conducted in the VGES and FITS facilities at Sandia. Large-scale flame acceleration and detonation studies are conducted in the FLAME facility. In addition, Sandia has worked on detonation phenomena in conjunction with Dr. John H. S. Lee at McGill University. The Radiant Heat Facility and the Solar Thermal Test Tower are used to simulate hydrogen burn environments for full-scale testing of actual pieces of equipment.

Sandia is also conducting severe fuel damage experiments in the Annular Core Research Reactor. These experiments are designed to investigate the behavior of reactor fuel under conditions similar to or worse than those at TMI-2. The tests are using new diagnostic techniques to allow direct visual observation of fuel damage and measurement of the amount of hydrogen produced. This research is relevant to questions of rate and amount of hydrogen generation in a degraded core accident and will determine the validity of computer codes like MARCH.

Sandia is conducting 3 programs related to containment integrity. These programs include the Containment Safety Margins Program, in which models of steel containments have been pressurized to failure, for the purpose of determining the behavior of containment structures under accident loading and to validate the analytical methods; the Integrity of Containment Penetrations under Severe Accident Loads Program, which will assess the integrity of mechanical penetrations such as equipment hatches, personnel airlocks, bellows, drywell head, piping penetrations, and fuel transfer tube, including the ability of resilient seals and gaskets to withstand severe accident environments; and the Electrical Penetration Assemblies Program, which will determine leakage through these penetrations in severe accident environments. Such information is of obvious relevance to Issue #8.

B. Analytical Research

A great amount of analytical research has been conducted by Sandia as well. Sandia has conducted an interim assessment of the MARCH code, which has been relied upon by Applicants for calculating the hydrogen source term.

Sandia has developed the state-of-the-art HECTR code for modelling hydrogen deflagrations. HECTR incorporates experimental data from Sandia experimental programs, such as a flame speed correlation determined from VGES experiments. HECTR has recently been used to model the TMI-2 accident hydrogen burn, with good agreement with the measured conditions during the accident.

Sandia has developed the HYBER algorithm to model combustion processes in nuclear reactor containments and to estimate the thermal response of equipment subjected to the resultant severe environment.

Other codes include vortex dynamics, used to model flame acceleration, including acceleration to detonation (and has favorably modelled experimental results at McGill) and CSQ, used to model dynamic loading.

C. Sandia Publications

The following list of published material illustrates the great amount of research conducted by Sandia in the areas of hydrogen behavior, combustion, and control and containment integrity.

"Hydrogen Behavior in Light Water Reactors" by Berman and Cummings, Nuclear Safety, Vol. 25, No. 1, Jan-Feb 1984, pp. 53-

74.

NUREG/CR-1561, "The Behavior of Hydrogen During Accidents in Light Water Reactors"

NUREG/CR-2017, "Proceedings of the Workshop on the Impact of Hydrogen on Water Reactor Safety"

NUREG/CR-2285, "Interim Technical Assessment of the MARCH Code"

NUREG/CR-2726, "Light Water Reactor Hydrogen Manual"

NUREG/CR-2530, "Review of the Grand Gulf Hydrogen Igniter System"

NUREG/CP-0033, "Proceedings of the Workshop on Containment Integrity"

NUREG/CR-2864, "Identification of Safety-Related Equipment for Analysis and Testing in the Hydrogen Burn Survival Program"

NUREG/CR-2865, "Hydrogen Combustion in Aqueous Foams"

NUREG/CR-1831, "Hydrogen Distribution After a Loss of Coolant Accident in the Subdivided Containment of Light Water Reactors"

NUREG/CR-2481, "Light Water Reactor Safety Research Program Semiannual Report"

NUREG/CR-2730, "Hydrogen Burn Survival Preliminary Thermal Model and Test Results"

NUREG/CR-2549, "Background Study and preliminary Plans for a Programon the Safety Margins of Containments"

NUREG/CR-3234, "The Potential for Containment Leak Paths Through Electrical Penetration Assemblies Under Severe Accident Conditions"

NUREG/CR-3131 "Containment Integrity Program FY82 Annual Report"

NUREG/CR-3463, "An Evaluation of HECTR Predictions of Hydrogen Transport"

NUREG/CP-0038, "Proceedings of the Second International Conference on the Impact of Hydrogen on Water Reactor Safety"

NUREG/CR-2080, "A Review of Hydrogen Detection in Light Water Reactor Containments"

NUREG/CR-3273, "Combustion of Hydrogen-Air Mixtures in the VGES Cylindrical Tank"

NUREG/CR-3779, "The Hydrogen Burn-Equipment Response Algorithm (HYBER)"

NUREG/CR-3721, "Pressure Measurements in a Hydrogen Combustion Environment, An Evaluation of Three Pressure Transducers"

NUREG/CR-3719, "Detonation Calculations Using a Modified Version of CSQII Examples for Hydrogen-Air Mixtures"

NUREG/CR-3521, "Hydrogen Burn Survival Experiments of FITS"

NUREG/CR-3835, "Simulation of Flame Propagation Through Vorticity Regions Using the Discrete Vortex Method"

NUREG/CR-4138, "Data Analysis for Premixed Combustion Tests performed at the Nevada Test Site (NTS)"

IV. Conclusion

As demonstrated above, the Sandia National Laboratory employs the "NRC personnel" having direct personal knowledge of hydrogen generation, combustion and control, containment integrity, and analytical/modelling techniques. In addition, Sandia, under the direction of the witness sought, Dr. Berman, has evaluated the Grand Gulf igniter system and has found it wanting. The Staff does not agree with Sandia's conclusion. (Since Applicants have taken great pains to demonstrate the similarities between Grand Gulf and Perry, analyses of Grand Gulf are relevant here.)

These conditions meet the "exceptional circumstances" test of 10 CFR 2.720(h)(2)(i), as interpreted by ALAB-715. Dr. Berman's testimony is necessary to ensure the completeness of the record on Issue #8 and to resolve a genuine scientific disagreement on a central issue in the adjudicatory process.

OCRE prays that the Board is so moved.

Respectfully submitted,

Susan L. Hiatt

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EXHIBIT 1

22 TMI-2 REQUIREMENTS

22.2 TMI Action Plan Requirements for Applicants for Operating License

II.B.7 Analysis of Hydrogen Control (and)
II.B.8 Rulemaking Proceedings on Degraded-Core Accidents

Introduction and Summary

As previously reported in the SER, the staff has requested that the applicants propose a program to improve the hydrogen control capability for the Grand Gulf Nuclear Station to the extent that the plant may safely accommodate the consequences of a postulated degraded-core accident with concomitant, large hydrogen releases. This includes the release of hydrogen generated from a metal-water reaction involving up to 75 percent of the active fuel cladding.

The staff also reported in the SER that the applicants had selected a hydrogen ignitor system for installation similar to that installed in operating ice-condenser plants and that review of the hydrogen ignition system, aided by technical assistance from the Sandia National Laboratory (SNL), was under way.

The installation of an ignitor system in the Grand Gulf containment to control hydrogen accumulation from postulated degraded-core accidents represents the application of a technology that has undergone a limited amount of testing and analysis as well as the first detailed consideration of these issues for a Mark III BWR containment. The applicants have, therefore, committed to an ongoing research program to investigate the efficacy of controlled ignition in the Grand Gulf facility. This program will include additional testing to determine the performance of ignitors above the suppression pool, and in a humid, hydrogen-rich environment representative of drywell conditions in certain postulated accidents. A more detailed discussion of the research effort is provided later in this supplement. As a result of these considerations, the staff intends to review the Grand Gulf ignition system in two phases, interim and final. The staff has completed its interim evaluation of the ignition system as discussed in this supplement to the SER. The staff's evaluation provides the basis for concluding that the ignition system is acceptable for an interim period of approximately 1 year from the date of issuance of the full-power license. Before completing the final evaluation of the ignition system, the staff will consider further certain issues related to controlled ignition. These issues include the items cited by the applicants as subjects for future testing and analysis.

As part of the review of the Grand Gulf hydrogen program, the staff obtained technical assistance from SNL. The purpose of this assistance was to perform an independent assessment of several specific review issues, including the following: (1) adequacy of the location and distribution of the ignitors, (2) analysis of the containment atmosphere pressure and temperature response, (3) likelihood and consequences of local detonations, (4) containment atmosphere mixing mechanisms, and (5) actuation criteria for the hydrogen ignition system (HIS). A detailed discussion of the SNL review is presented in NUREG/CR-2530.

As stated above, SNL, as part of its general review of the Grand Gulf igniter system, investigated several specific issues. With regard to the distribution of igniters, SNL concluded that the system design was valid and recommended certain improvements as discussed below. Acknowledging that it is difficult to assess the degree of mixing in containment, SNL judged that, conditional to containment spray operation, the upper containment region should be well mixed. Because of the compartmentalized configuration of the annular region between the drywell and containment walls, SNL had to rely on the simplified analytical models that result in the burning of hydrogen when requisite hydrogen concentrations are reached within nodal volumes. SNL stated that actual atmosphere conditions within containment, together with discrete ignition sources, would promote a complex series of local burns that may be less severe than the current analysis shows for hydrogen combustion.

Considering the issue of local detonations, it was SNL's conclusion that the likelihood of forming detonable mixtures is small, particularly for significant-sized volumes. SNL also judged that the likelihood of local detonation occurring, presuming the existence of a detonable mixture, is very small. A discussion of the consequences of a postulated local detonation is provided later in this supplement.

Regarding the adequacy of the HIS actuation criteria, SNL has judged, and the staff agrees, that the applicants' criteria for energizing the igniters is acceptable. SNL did suggest, however, that automatic activation of the igniters be added, a feature which is currently not proposed by the applicants. The staff will consider this suggestion further during the upcoming final phase of its review.

The net result of the SNL evaluation was its conclusion that the Grand Gulf hydrogen ignition system, as currently designed, is marginally adequate to meet the threat posed by hydrogen releases within the containment building. This characterization translates to the condition where for most situations, the system is predicted to assist in maintaining the pressure below the specified containment capability, but that in certain less likely situations, calculations predict excessive pressures. Central to this determination is SNL's concern that the available analytical techniques offer simplified models of the containment and of the combustion processes involved. Furthermore, it is SNL's position that uncertainties in the analysis of degraded-core accidents for Grand Gulf contribute to its view that the igniter system is marginally adequate. These uncertainties exist in the knowledge of the hydrogen release rate, the degree and rate of mixing within the wetwell/containment region, the ignition and propagation behavior of hydrogen burns, and the availability of the containment spray system.

As part of its review, SNL identified two areas where it believes the igniter system design may be improved. SNL recommended that the number of igniters served by a circuit breaker be reduced based on consideration of their location. In addition SNL recommended that, where feasible, greater consideration be given to the nature of directional flame propagation when locating igniters or that the number of igniters in the wetwell region be increased.

The staff has reviewed the SNL analysis of the Grand Gulf igniter system and finds it to be supportive of the staff's interim approval. While the staff does not at this time concur with all of the conclusions, suggestions, or recommendations made by BNL, it believes that the overall independent BNL analyses buttress the staff's findings. As stated previously, BNL has found the HIS, as it is currently designed, to be marginally adequate. The BNL review did not evaluate the HIS from the perspective of interim versus final evaluation. Therefore, this evaluation can be construed as a final evaluation based on present, albeit incomplete, knowledge. The staff does not agree that the HIS is marginal with respect to adequacy; however, the staff finds its interim approval consistent with such a determination. The staff also concludes that it is prudent to continue the review of the HIS in order to improve upon the system and to increase the staff's understanding of the safety margins provided by the system in the unlikely event of a degraded-core accident.

<u>System Description</u>

HIS is a system of igniters and ancillary equipment MP&L has installed within the Grand Gulf containment. This system is required to function only in the unlikely event that excessive quantities of hydrogen, well beyond the design-basis requirements of 10 CFR 50.44(d), are generated as a result of a postulated severely degraded-core accident. The HIS is designed to promote the combustion of hydrogen in a manner such that containment overpressure failure is prevented.

The HIS installed in the Grand Gulf Nuclear Station consists of 90 igniter assemblies distributed throughout the drywell, wetwell, and upper containment, with the wetwell defined as the volume between the suppression pool and an approximate elevation of 135 ft. This elevation represents the location of the first ceiling above the pool. There are 18 igniters in the drywell and 11 in the wetwell. The remaining 61 igniters are located in the upper containment; 16 of these are installed in the upper dome region mounted on the spray ring header supports.

The igniter selected by MP&L is a glow plug (commonly used in diesel engines) that is manufactured as Model 7G by General Motors AC Division and is identical to that installed in the Sequoyah and McGuire nuclear plants. The igniter is powered directly from a 120/12 V transformer that has multitap capability.

The igniter assembly includes the igniter enclosure and the junction box. The igniter enclosure consists of a stainless steel box with 1/8-in.-thick walls, which houses the transformer and associated electrical connections and partially encloses the igniter. The sealed box uses a hooded spray shield to reduce water impingement on the glow plug.

The igniters are powered from Class 1E power panels that have normal and alternate ac power supply from offsite sources. In the event of a loss of offsite power the igniters would be powered from the emergency diesel generators. In addition, the HIS is designed as a seismic Category I system.

The HIS is designed so that it can be manually actuated from the main control room following the start of an accident, and it can remain actuated until the threat to containment integrity resulting from hydrogen release has passed. The applicants have selected a duration of seven days as a criterion for continuous HIS operation. The system is designed to be actuated by operating two

EXHIBIT 2

Professional Qualifications
of
Marshall Berman

My name is Marshall Berman. My home address is 4706 Hilltop, NE, Albuquerque, New Mexico. I am presently employed by Sandia National Laboratories as supervisor of the Reactor Safety Studies Division. This division is presently engaged in performing research for the NRC on (LWR) accident phenomenology for light water reactors. Current research topics include the interaction of core materials with concrete, steam explosions, emergency sump hydraulics and the behavior and control of hydrogen released during LWR accidents.

Current Related Experience

The NRC-funded hydrogen research program began in September, 1979. Major accomplishments to date include the preparation of a detailed program plan, the publication of two major reports entitled "The Behavior of Hydrogen During Accidents in Light Water Reactors" and "Analysis of Hydrogen Mitigation for Degraded Core Accidents in the Sequoyah Nuclear Power Plant", the organization and conduct of an international Workshop on the Impact of Hydrogen on Water Reactor Safety, and the performance of an experimental test series investigating lean mixture hydrogen combustion.

Educational and Professional Background

I received a B.S. in Physics, cum laude, from the University of Michigan in 1961, and a Ph.D in nuclear physics from Wayne State University in 1968. My thesis topic was the study of nuclear resonance fluorescence in Xe^{131}. I am a member of the American Physical Society, Sigma Xi, and the American Nuclear Society.

From 1961 to 1964, I was employed by Chrysler Corporation Missile Division. I was engaged as a theoretical physicist studying the interaction of electromagnetic waves with plasmas, radar cross sections, antenna theory, and the electromagnetic generation of high dynamic buckling pressures.

From 1964 to 1965, I was employed by Ling-Temco-Vought Corporation, specializing in optics and spectrophotometry.

I joined Sandia in 1969 as a member of the technical staff. Job assignments included x-ray diagnostics, response function unfolding, and the development, modification and application of large computer codes to research problems. One- and two-dimensional radiation hydrodynamics codes were used for research on underground testing and containment, waste storage security, radiation transport and earth penetrators.

In 1974, I joined the reactor safety organization. Reasearch topics included the modification and application of the RELAP thermal-hydraulic computer code to LOCA studies, especially PWRs equipped with upper head injection, and statistical analysis of LOCAs. I was promoted to supervisor in 1978 and have managed and participated in programs in the following areas: Upper head injection, statistical analysis of LOCA, core-concrete interactions, steam explosions, two-phase jet loads, NRC licensing calculations, fission product transport, TMI studies, sump hydraulics, and hydrogen generation, transport, combustion and mitigation. I have written numerous reports and made many presentations on all the research cited above.

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CERTIFICATE OF SERVICE

This is to certify that copies of the foregoing were served by deposit in the U.S. Mail, first class, postage prepaid, this 18th day of MARCH, 1985 to those on the service list below.

Susan L. Hiatt

Susan L. Hiatt

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