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SEP 16 1982

Docket Nos. 50-315
and 50-316

Mr. John Dolan, Vice President
Indiana and Michigan Electric Company
Post Office Box 18
Bowling Green Station
New York, New York 10004

Dear Mr. Dolan:

We have identified more items for which additional information is required on hydrogen control issues for ice condenser plants. We need the information delineated in the enclosure to this letter to support our review. Please respond to this request by October 15, 1982.

The reporting requirements contained in this letter affect fewer than ten respondents, therefore, OMB clearance is not required under P.L. 96-511.

Sincerely,

Original signed by:
S. A. Varga

Steven A. Varga, Chief
Operating Reactors Branch No. 1
Division of Licensing

Enclosure:
Request for Additional
Information

cc w/enclosure:
See next page

OFFICE	ORB 1	LB 4	ORB 1				
SURNAME	RCilimberg	CStahle	SVarga				
DATE	9/16/82	9/16/82	9/16/82				

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Mr. John Dolan
Indiana and Michigan Electric Company

cc: Mr. Robert W. Jurgensen
Chief Nuclear Engineer
American Electric Power
Service Corporation
2 Broadway
New York, New York 10004

Gerald Charnoff, Esquire
Shaw, Pittman, Potts and Trowbridge
1800 M Street, N.W.
Washington, D. C. 20036

Maude Preston Palenske Memorial
Library
500 Market Street
St. Joseph, Michigan 49085

W. G. Smith, Jr., Plant Manager
Donald C. Cook Nuclear Plant
P. O. Box 458
Bridgman, Michigan 49106

U. S. Nuclear Regulatory Commission
Resident Inspectors Office
7700 Red Arrow Highway
Stevensville, Michigan 49127

William J. Scanlon, Esquire
2034 Pauline Boulevard
Ann Arbor, Michigan 48103

The Honorable Tom Corcoran
United States House of Representatives
Washington, D. C. 20515

James G. Keppler
Regional Administrator - Region III
U. S. Nuclear Regulatory Commission
799 Roosevelt Road
Glen Ellyn, Illinois 60137

ENCLOSURE

REQUEST FOR ADDITIONAL INFORMATION
ON HYDROGEN CONTROL FOR ICE CONDENSER PLANTS

1. A substantial number of laboratory tests were conducted as part of the ICOG/EPRI R & D Program for hydrogen Control and Combustion. Test results were transmitted from the utilities to NRC as they became available; however, for several of the research programs, only selected test results were reported and organized compilations of all pertinent test information were not provided. This information is required to confirm the adequacy of the test program and assumptions made in the containment analyses. In this regard provide the following:

   a) ACUREX

      i) a table of droplet size and droplet density estimates for each of the fog/spray tests;

      ii) a table of estimated flame speed for each test (flame speed should be calculable from thermocouple locations and ignition time data); and

      iii) pressure and temperature traces similar to those depicted in Figures 4-2 of the December 1981 ACUREX Project Report, but for tests 2.10, 2.11, and 2.12;

   b) FACTORY MUTUAL

      results of ignition tests in which a glow plug was used in place of the ignition electrodes;

   c) WHITESHELL

      tables summarizing pre- and post- burn conditions, igniter locations, maximum measured pressure rise, adiabatic pressure rise, completeness of burn, and estimated flame speed. These tables should be keyed to and cover all of the tests committed to in the test matrix (tables

1 - 4 in Appendix A.1 of the fourth quarterly report on the TVA research program, June 16, 1981) plus any additional AECL tests conducted under this program. Of particular interest to the staff are the results of the 8.5% H_2 test with 30% H_2O and top ignition. Discuss your plans for conducting tests at steam concentrations above 30%, as committed to in previous quarterly reports;

d) HEDL

- figures depicting concentration gradients for each of the tests. Figures provided should permit better resolution than those included in the previous submittal.

2. The majority of the ICOG/EPRI tests which serve to demonstrate the validity of the deliberate ignition concept utilized a GMAC glow plug as the ignition source. TVA currently intends to install 120 V TAYCO ignitors in the Permanent Hydrogen Mitigation System instead of the glow plugs. Although ignitor durability tests have been completed by Singleton, additional testing of the 120 V ignitor is required to show that it is an acceptable replacement for the GMAC ignitor. Specifically,

   a) tests should be conducted to ensure that the ignitor will continue to operate as intended in a spray atmosphere typical of that which would be expected in each region of containment where ignitors are to be located;

   b) endurance tests should be conducted on a suitable sample size to assure adequacy and consistency of ignitor surface temperature and lifetime.

3. For the 120 V ignitor system, describe the following:

   a) performance characteristics of the ignitors including surface temperature as a function of voltage and age;

b) a comparison of surface area, power density, and other relevant parameters for the original and currently proposed igniters;

c) igniter mounting provisions

d) proposed preoperational and surveillance testing. If surveillance testing will be based on comparisons of measured voltage/current to preoperational values, specify the range for acceptance;

e) power distribution system for the igniters, in particular, the location of the breakers in the system and the number of igniters on a breaker.

4) Provide details regarding the number and location of permanent igniters in containment. Discuss the influence of considerations such as volume served per igniter, and preferred flame direction on the design of the permanent system.

5) Recent tests conducted at McGill indicate that flame accelerations accompanied by large pressure increases, and detonations can occur at hydrogen concentrations as low as 13%. Although remote, the possibility of flame accelerations and local detonations occuring around obstacles and in confined regions of containment cannot be entirely dismissed. Further analysis of the probability and consequences of these events are thus warranted. In this regard:

a) Discuss the chain of events and conditions required to cause flame accelerations and detonations in containment, and the probability that such conditions might exist. Identify the locations in containment at which flame acceleration/detonation would most likely occur.

b) Provide quantitative estimates of the extent and magnitude of flame acceleration in containment and the resulting pressure increase and loads on structures and equipment.

c) Provide the results of a calculation (pressure versus time curve) for the largest conceivable local detonation which could occur in your containment. Demonstrate that the effects of such a detonation could be safely accommodated by structures and essential equipment. Also, provide an estimate of the limiting size of a cloud of detonable gas with regard to the structural capability of the containment shell.

6) The analysis provided to date concerning the survivability of air return fans and hydrogen skimmer fans neglects any fan overspeed or motoring which occurs as a result of postulated hydrogen combustion in the upper plenum and upper compartment. Describe how the fans will react to the differential pressure associated with hydrogen combustion, and justify the assumptions concerning fan overspeed. Describe the effects of combustion in the lower compartment e.g., fan stalling.

7) With regard to the equipment survivability analysis, the level of conservatism implicit in the temperature forcing functions developed for the lower containment and the upper plenum is not apparent and quantifiable. Additional analyses should be conducted to provide a baseline or "best estimate" of equipment response, and to ensure that temperature curves assumed in the analyses embody all uncertainties in the accident sequence and combustion parameters. Accordingly, provide analyses of equipment temperature response to:

1) the base case transient assumed in the containment analyses,

2) the containment transients resulting from a spectrum of accident scenarios; and

3) the containment transients resulting under different assumed values for

flame speed and ignition criteria for the worst case accident sequence. The range of these combustion parameters assumed for the equipment survivability analyses should include but not necessarily be limited to the values assumed in the containment sensitivity studies, i.e., 1 - 12 ft/sec flame speed and 6 - 10% hydrogen for ignition.

8) For the survivability analysis, it is our understanding that the current thermal model assumes radiation from the flame to the object only during a burn, with convection occurring at all times outside the burn period. In an actual burn, radiation from the cloud of hot gases following the flame front can account for a substantial portion of the total heat transfer to the object. An additional heat flux term or a combined radiation-convection heat transfer coefficient should be used to account for this radiant heat source. In this regard, clarify the treatment of heat transfer following the burn and justify the approach taken.

9) HEDL containment mixing tests conducted as part of the ICOG/EPRI R & D program indicate that spatial hydrogen concentration gradients of as much as 2 to 7% can be expected to exist within containment at a given time. If such a gradient were to exist within the volume of a hydrogen cloud in which combustion has just been initiated, the volume-average hydrogen concentration for the cloud can conceivably be significantly higher than the hydrogen concentration at the point of ignition. In light of this, discuss the influence of hydrogen concentration gradients on the concentration requirement for ignition that is input to CLASIX, and justify the ignition concentration value used in the CLASIX containment analyses.

10) Describe in detail the fog formation study cited in response to question 9 of the July 21, 1981 Request for Information. Include in this description the analytical development of the models for fog formation and removal, methods

for solution, assumptions, and input parameters. Provide plots of fog concentration and size as a function of time assuming various spray removal efficiencies, and mean droplet diameters.

11) Describe in detail the analyses of fog effects on hydrogen combustion cited in response to question 9 of the July 21, 1981 Request for Information. Include in this description the analytical development of the combustion kinetics and heat transfer models, and quantitative comparisons between the theoretical results and data obtained from the Factory Mutual Tests. Provide plots of fog droplet size and concentrations required to inert at various hydrogen concentrations under typical post-LOCA containment conditions.

12) In the CLASIX spray model it is not clear whether the mass of spray treated in a time increment is assumed to be only that amount of spray mass which is introduced in a single time step, or the mass of droplet accumulated in the atmosphere over the fall time period. Clarify the spray mass accounting used in CLASIX and the mass of spray treated in a single time step. Discuss the significance of any errors introduced by the apparent assumtion that only one time increment of spray mass is exposed to the containment atmosphere during a single time step.

13) CLASIX spray model analyses provided to date have been limited to the comparison of pressure, temperature, and integrated heat removal for the purpose of evaluating the effect of the spray operating in a separate time domain. Additional information is needed, however, to confirm the adequacy of the heat and mass transfer relationships and assumptions implicit in the CLASIX spray model, especially in treating a compartment in which hydrogen combustion is taking place. In this regard:

a) Provide a quantitative description of the spray heat and mass transfer under containment conditions typical of a hydrogen burn. Include in your response plots of containment temperature, spray heat transfer, spray mass evaporation, and suspended water mass as a function of time for both the CLASIX spray model and a model in which the spray mass is tracked throughout the fall (and allowed to accumulate in the containment atmosphere).

b) Provide analyses of spray mass evaporation and pressure suppression effects for an upper compartment burn.

c) Justify the drop film coefficient value assumed in the spray model analyses (20 Btu/h ft^2°F) and discuss the effect of using a constant value throughout a burn transient.

14) Concerning the CLASIX containment response analyses:

a) Justify the burn time and burn propagation delay times used (reported burn times for Sequoyah and McGuire differ by a factor of 2 to 3);

b) Justify the radiant heat transfer beam lengths used (a beam length of 59 ft. for the lower compartment in Sequoyah seems high - 20 to 30 ft. may be more appropriate);

c) The base case and majority of S_2D sensitivity studies assume that combustion occurs at an 8% hydrogen concentration with an 85% completeness of burn. Available combustion data for hydrogen/dry air mixtures indicate that lean mixtures of approximately 8% H_2 and below are prevented from reacting completely and adiabatically due to buoyancy, diffusion and heat loss effects. Only as hydrogen concentration is increased to about 8.5% will the reaction begin to approach adiabaticity. While arguments for an 8% ignition concentration may be valid, provide the results of additional

CLASIX analyses to indicate the effect of an increase in ignition concentration from 8% to 8.5-9%.

d) Provide the results of CLASIX analyses for flame speeds of 10 and 100 times the present value;

e) To assess the effect of igniter system failure or ineffectiveness, provide the results of sensitivity studies in which the lower and dead-ended compartments are effectively inerted, and the upper plenum igniters burn with low efficiency or not at all. Assume combustion in the upper compartment at 9-10% hydrogen.