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February 9, 1984

NUCLEAR PRODUCTION DEPARTMENT

U. S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D. C. 20555

Attention: Mr. Harold R. Denton, Director

Dear Mr. Denton:

SUBJECT: Grand Gulf Nuclear Station
Units 1 and 2
Docket Nos. 50-416 and 50-417
License No. NPF-13
File 0260/0272/0756
Reference: Safety Evaluation
Report Supplement No. 4
NUREG-0831
Quarterly Status Report -
September 30, 1983,
"Degraded Core Accident
Hydrogen Control Program"
AECM-84/0099

The Nuclear Regulatory Commission (NRC) Staff in Supplement No. 4 to the Safety Evaluation Report (SER) requested that Mississippi Power & Light (MP&L) submit to the NRC quarterly reports on the status of the "Degraded Core Accident Hydrogen Control Program." In response to that request MP&L is herewith submitting the first of these status reports. This report covers the time period since the issuance of Supplement 4 to the SER (May, 1983) through September 30, 1983, and provides formal documentation of the activities conducted during that time period in the form of a summary description.

Should you have any questions concerning this report, please contact us.

Yours truly,

S H Hobbs

for L. F. Dale
Manager of Nuclear Services

DBH/SHH:sap
Attachment

cc: (See Next Page)

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cc: Mr. J. B. Richard (w/a)
Mr. R. B. McGehee (w/o)
Mr. T. B. Conner (w/o)
Mr. G. B. Taylor (w/o)

Mr. Richard C. DeYoung, Director (w/a)
Office of Inspection & Enforcement
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Washington, D. C. 20555

Mr. J. P. O'Reilly, Regional Administrator (w/a)
U.S. Nuclear Regulatory Commission
Region II
101 Marietta St., N.W., Suite 2900
Atlanta, Georgia 30303

Quarterly Status Report for
Quarter Ending September 30, 1983

"Degraded Core Accident
Hydrogen Control Program"

Grand Gulf Nuclear Station
Units 1 and 2
Docket Nos. 50-416 and 50-417

Mississippi Power & Light Company

Ilsdl

Quarterly Status Report - September 30, 1983

"Degraded Core Accident Hydrogen Control Program"

1.0 Introduction

This quarterly status report is submitted to comply with a requirement in Supplement Number 4 to NUREG 0831, Safety Evaluation Report Related to the Operation of Grand Gulf Nuclear Station Units 1 and 2. This requirement specifies that Mississippi Power & Light (MP&L) should provide quarterly reports outlining the status of the on-going research program to address degraded core hydrogen control requirements. This report covers the time period since the issuance of Supplement 4 to the SER through September 30, 1983.

This report includes brief summaries of the submittals made by MP&L since the issuance of Supplement 4 to the SER along with summaries of meetings between the NRC staff and MP&L. MP&L is participating in the Hydrogen Control Owners Group (HCOG) which is conducting generic research and completing generic analyses to resolve the degraded core hydrogen control issue. Since the work completed by HCOG complements MP&L's program to resolve this issue, this report also includes summaries of meetings between the HCOG and the NRC. The summaries of these meetings included in this report do not reflect a formal HCOG position with respect to any issue and represent only the MP&L interpretation of the meetings.

2.0 Summary of MP&L Submittals

AECM-83/0212, June 16, 1983

MP&L letter number, AECM-83/0212, dated June 16, 1983, endorsed the HCOG's responses to several Requests for Additional Information (RAIs) from the NRC. The letter also provided MP&L plant specific responses to several of the RAIs. Finally the letter transmitted copies of the CLASIX-3 Grand Gulf Drywell Break Sensitivity Summary, Report No. OPS-38A54 Revision C. This report was prepared as part of MP&L's plant specific response to one of the NRC's RAIs and provided additional CLASIX-3 sensitivity study results for the scenario involving a small break accident in the drywell. MP&L concluded on the basis of the plant specific response submitted with this letter and the generic HCOG responses that sufficient information had been submitted to close the RAIs pending completion of on-going work on the hydrogen control Emergency Procedure Guideline.

AECM-83/0339, June 23, 1983

MP&L letter number AECM-83/0339, dated June 23, 1983, provided an evaluation of the ignitor performance under worst case plant conditions. MP&L postulated maximum loading on the ESF busses, maximum power grid degradation and containment and drywell environmental conditions at worst possible conditions. This evaluation showed that using these extremely conservative assumptions, the ignitor surface temperature would still exceed 1500°F. This temperature has been demonstrated by tests performed

at Lawrence Livermore Laboratories to be sufficient to ignite hydrogen under the most adverse environmental conditions. MP&L noted that if the class 1E busses were loaded to their maximum, the ECCS would be fully functional which would imply that the hydrogen generation event had been terminated. MP&L concluded that the Grand Gulf HIS will perform its intended function under worst case, degraded conditions.

AECM-83/0455, August 13, 1983

MP&L's letter number AECM-83/0455, dated August 13, 1983, provided initial responses to concerns raised by the NRC in a letter dated July 22, 1983. The letter responded to concerns regarding high local temperatures observed in the HCOG's 1/20th scale test facility as a result of steady diffusion flames, and to concerns regarding the temperatures in the drywell compartment as calculated by the CLASIX-3 computer code. MP&L endorsed the HCOG commitment in HGN-012 (August 12, 1983) to perform the 1/4th scale tests.

A number of conservatisms in the results obtained from the 1/20th scale tests were identified. These tests did not model containment sprays which will provide substantial cooling of the ambient containment atmosphere which in turn should lower the temperatures of the gas plume above the diffusion flames. The 1/20th scale tests overpredict flame heights and preliminary results from a 1/5th scale single sparger test showed that the flame heights may be overpredicted by as much as a factor of 2. The temperature and heat flux sensors in the 1/20th scale facility were located at the hottest location in the test facility with minimal disruption for the upward flow of the hot gases. Finally, the 1/20th scale tests did not provide any data on radial or circumferential temperature gradients away from the diffusion flames which will reduce temperatures at the equipment locations.

The letter provided a brief summary of the work which will be completed by HCOG to define potential hydrogen release rates for a range of degraded core accidents using the BWR Core Heatup Code. This summary showed that high hydrogen release rates above 0.8 lbm/sec cannot be sustained for any substantial periods of time without resulting in gross core melting. The work completed with the BWR Core Heatup Code showed that release rates of 0.8 lbm/sec could not be sustained for even 10 minutes without substantial core melting. The letter noted that the HCOG is committed to providing a comprehensive definition of potential hydrogen release rates for a range of initial accident conditions.

Letter AECM-83/0455 contained preliminary evaluations of the capability of equipment to survive the thermal environments produced by diffusion flames. Selected components were evaluated using the full scale thermal environment defined from 1/20th scale test results. The equipment was shown to survive the expected duration of the diffusion flame assuming that gross core melting did not occur. Three components were also evaluated against a thermal environment which was defined from the 1/20th scale test data and which incorporated an estimate of the effects of containment sprays. Finally, the letter included a revised list of equipment which must survive degraded core accidents.

The July 22 letter from the NRC to MP&L identified some concerns over the calculation of temperatures in the drywell using the CLASIX-3 code. MP&L provided a revised drywell break accident scenario base case analysis in AECM-83/0455 using revised heat transfer correlations and treatment of steam condensation in the drywell to maximize compartment temperatures. A number of other factors were also revised in the new base case including the flow split between the drywell and the ADS spargers, the timing of the flow split and pool drawdown, the flow area from the vacuum breaker and the purge compressor capacity. MP&L committed to evaluate the results from the revised base case and to complete additional supporting analyses. This evaluation and results from additional analyses will be provided in future submittals (See AECM-83/0455).

The sensitivity of the revised base case to several parameters was evaluated in the August 13 submittal. MP&L investigated modeling a postulated continuous burn in the drywell, discharge of all energy into the drywell, and altering the amount of suppression pool water which is drawn down from the suppression pool and stored in the reactor vessel.

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MP&L's letter number AECM-83/0455, dated August 23, 1983, provided additional information to respond to the NRC's July 22 letter. The letter provided information on the methodology used to define a thermal environment based on 1/20th scale test data for two hydrogen flow rates, additional evaluations of equipment survivability, and supplemental information on calculations of temperatures in the drywell for a small break accident scenario.

The full scale thermal environment which was defined using 1/20th scale test data included bulk gas temperatures and heat fluxes incident on equipment. The gas temperatures were defined using some assumptions to account for the effects of containment sprays. The gas velocities for use in defining convective heat fluxes were determined from visual data and from measurement of convective heat flux at the HCU floor. Radiative heat fluxes produced from hot water vapor in the vicinity of the diffusion flame and from grating at the HCU floor elevations were determined. The thermal environment definition included estimates of the vertical attenuation of the temperatures along the containment wall.

Letter AECM-83/0479 contained additional information on equipment survivability. MP&L completed additional evaluations of representative components against the thermal environment which would be produced by combustion at a hydrogen release rate of 0.4 lbm/sec (full scale). Details of the methodology used to model components and calculate component response to diffusion flame thermal environments were provided. MP&L provided revised lists of equipment in the containment and drywell which must survive hydrogen combustion. MP&L noted that further evaluations of the need to include some components on the equipment list are in progress.

MP&L provided additional information on the calculation of temperatures in the drywell using the CLASIX-3 code in AECM-83/0479. The information which was provided included additional variations of the drywell break base case to account for operation of the vacuum breakers on the drywell purge compressor discharge line, operation of two drywell purge compressors, and variations in the beam length for radiant heat transfer. MP&L also committed to complete additional evaluations of the drywell temperatures based on revised hydrogen and steam release rates calculated using the MARCH computer code.

2.1 Planned Future Submittals

MP&L intends to submit the balance of information necessary to resolve the NRC's questions on calculation of temperatures in the drywell using the CLASIX-3 code. This information will include additional evaluations of potential hydrogen and steam release rates using the MARCH computer code.

3.0 Summary of Meetings

HCOG and NRC Meeting on June 29, 1983

The HCOG met with the NRC on June 29, 1983, to review the results from the HCOG's research program. The HCOG presented results from combustion visualization tests conducted in a 1/20th scale test facility and from hydrogen rich atmosphere flammability limit tests completed in a small vessel. Early scoping studies using the BWR Core Heatup Code to provide a more mechanistic definition of expected hydrogen release rates were also reviewed.

The 1/20th scale tests showed that the hydrogen combustion for full scale constant hydrogen flow rates greater than approximately 0.4 lbm/sec will be characterized by steady diffusion flames anchored at the suppression pool surface. Very late in the transient, i.e. when the oxygen concentration decreases to approximately 6%, the flames lift briefly to the HCU floor level before extinguishing. The temperature sensors included in the tests showed temperatures just below the HCU floor ranging primarily between 560°F and 700°F for the base case. The heat flux measurements indicated a total heat flux of approximately 4000 Btu/hr with a convective component of approximately 3200 Btu/hr ft^2. The severity of the thermal environment resulting from the 1/20th scale tests showed a close relationship with the hydrogen release rate used in the tests.

The HCOG emphasized during the June 29 meeting that the 1/20th scale results are extremely conservative with respect to expected full scale conditions. Laminar effects in the 1/20th scale test facility result in taller than prototypical flames. The location provided with instrumentation was believed to be the location with the most severe thermal environment in the test facility. The sensors were placed in a chimney where products of combustion were moving upward into the containment and were directly above two active SRV spargers. No containment sprays or unit coolers were provided in the facility.

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The HCOG also completed a series of tests to establish upper flammability limits for hydrogen rich atmospheres with high concentrations of steam present. Both quiescent and turbulent conditions were investigated using a 17 liter reaction vessel at AECL's Whiteshell Nuclear Research Center.

The results from these tests showed that ignition limits using the glow plug ignitor agree with the established flammability limits. Fan induced turbulence had no discernible effects on the ignition limits. The ignitor surface temperature required to initiate combustion did not appear to be a strong function of steam concentration. The data obtained from the tests confirms the ignition points assumed in the CLASIX-3 analysis of hydrogen combustion in the drywell.

The HCOG is also completing additional testing to define the ignition limits associated with a steam condensation environment. Most of the tests were completed as of the June 29 meeting, but data reduction was still in progress.

The results from the HCOG's scoping study using the BWR Core Heatup Code to calculate hydrogen release rates demonstrated that hydrogen production during core heatup is limited by steam supply. Unmitigated accidents do not produce the maximum hydrogen production rate or maximum total hydrogen production. The maximum hydrogen production rate appears to occur in early phases of recovering the core when the fuel is in an advanced stage of core heatup.

During the June 29 meeting with the NRC, the HCOG presented a brief discussion of an emergency procedure guideline (EPG) addressing hydrogen control which had been prepared by the HCOG and forwarded to the BWR Owners Group. The guideline provides guidance for operator actions necessary to assure adequate hydrogen control measures are implemented for Mark III containments during degraded core accidents.

HCOG and NRC Meeting on July 28, 1983

The HCOG again met with the NRC on July 28, 1983. The purpose of this meeting was to address several concerns raised by the NRC relative to results from the HCOG's research program. The HCOG presented additional information on further analyses using the BWR Core Heatup Code. The results of all code runs completed as of the meeting indicate that sustained hydrogen releases sufficient to achieve a 75% metal water reaction are attainable only for very low reflood rates of between 100-200 gpm. These flow rates are expected to produce hydrogen release rates from 0.2 to 0.4 lbm/sec and substantial zircaloy melting would be expected to occur.

As a result of concerns expressed by the NRC, the HCOG provided a discussion of the distributed ignition system (DIS) capability. The DIS has been shown to protect the containment from pressure effects of deflagrations and diffusion flames. MP&L has demonstrated that equipment which is required to survive can survive deflagration type combustion. The HCOG believes and MP&L concurs, that sufficient information exists to demonstrate that this equipment should survive postulated diffusion

flames produced by realistic hydrogen release rates when proper credit is taken for containment sprays or unit coolers. Finally, the DIS precludes pocketing of hydrogen, inadvertent operation of the DIS has no impact on the plant, and the system has no adverse effects on normal plant operation.

At the conclusion of the July 28 meeting, the HCOG committed to complete two confirmatory tasks to assure the adequacy of the ignitor system. The HCOG committed to use the BWR Core Heatup Code to analyze hydrogen release rates. A range of reflood flow cases will be analyzed. The expected maximum sustained hydrogen flow is below 0.2 lbm/sec for sequences which lead to a total of 75% MWR. This would correspond to deflagration type combustion as previously analyzed.

The final commitment made by the HCOG was an agreement to complete a series of tests in a 1/4th scale model of a full Mark III containment. The tests will be used to define a thermal environment for equipment survivability analyses. The test will utilize realistic hydrogen release rates, incorporate effects of containment sprays or unit coolers as appropriate, and eliminate the conservatisms inherent in completion of small scale tests.

MP&L and NRC Meeting on August 5, 1983

MP&L met with the NRC on August 5 to review MP&L's response to the NRC's July 22 letter, to review the activities which must be completed prior to issuance of a full power license for GGNS and to discuss the HCOG research program. MP&L outlined the contents of their submittal to respond to the NRC's July 22 letter. The NRC offered suggestions on additional information which should be included in the submittal.

The NRC discussed the schedule for submitting all information in order to support MP&L's needs for a full power license. MP&L committed to submit information on a timely basis to support the NRC's proposed review schedule.

The commitments made by HCOG during the July 28 HCOG-NRC meeting were reviewed. A meeting date was established to review HCOG's use of the BWR Core Heatup Code. The schedule for completing the 1/4th scale tests was reviewed. The NRC expressed a desire to review the facility design as early as possible and provide comments to the group.

MP&L and NRC Meeting on August 17, 1983

An MP&L representative met with the NRC on August 17 to discuss issues and a possible agenda for the HCOG and NRC meeting on August 23 and 24 to assure that appropriate MP&L open issues were addressed in that meeting.

HCOG and NRC Meeting on August 23 and 24, 1983

The HCOG met with the NRC on August 23 and 24 to review the application of the BWR Core Heatup Code. During the meeting, the HCOG presented details of the geometric model, radiant and convective heat transfer models, zircaloy oxidation modeling in the code, and treatment of core recovery.

Additional details were provided concerning the scoping study completed using the BWR Core Heatup Code. The results from the scoping study showed that the maximum hydrogen production occurs in the early phase of reflooding the core, assuming that the core is in a very advanced stage of heatup. The absolute peak hydrogen production rate increases with increasing core coolant injection. However, the duration of high hydrogen release rates and the total amount of hydrogen produced decrease dramatically with increasing core coolant injection flow. In addition, the NRC indicated an interest in HCOG investigating various potential accident sequences and the resulting hydrogen production.

3.1 Planned Future Meetings with NRC

MP&L anticipates meeting with the NRC under the auspices of HCOG to discuss the planned 1/4th scale test. This discussion would cover test objectives and facility design.

4.0 Test Program Status

The summaries and status of the HCOG test programs as stated here do not reflect the HCOG position with respect to any test program and represent only MP&L's interpretation of these programs.

4.1 1/20th Scale Test Program Status

Preliminary results of the tests were presented to the NRC at the HCOG meeting on June 29, 1983 (See previous discussion on the meeting for more information).

Preliminary analysis of equipment survivability for Grand Gulf which utilized the results of the 1/20th scale tests were presented to the NRC in letters AECM-83/0455, dated August 13, 1983, and AECM-83/0479, dated August 23, 1983.

4.1.1 Planned Activities in the 4th Quarter of 1983

Report on the 1/20th scale tests to be issued.

4.2 1/4th Scale Test Program Status

HCOG committed to perform 1/4th scale tests during a meeting with NRC on July 28, 1983, and confirmed that commitment in HGN-012 on August 12, 1983. HCOG also provided a preliminary design report for the test facility and a detailed report summarizing the scaling basis in HGN-012.

MP&L endorsed the HCOG 1/4th scale test program in AECM-83/0455 on August 13, 1983.

During September 1983, the site preparation and construction of foundations were started.

4.2.1 Planned Activities in the 4th Quarter of 1983

Continue construction of test facility. Continue instrumentation design and equipment procurement.

4.3 Ignition Effectiveness Tests in Rich Hydrogen - Air-Steam Mixtures

Tests to measure the ignition effectiveness of the GM AC 7G Glow Plug in rich hydrogen-air-steam mixtures were conducted using a 17 liter reaction vessel at AECL's Whiteshell Nuclear Research Center. These tests were completed during this quarter. Supplemental tests investigating the ignition limits associated with a steam condensation environment were continued into the 4th quarter.

4.3.1 Planned Activities in the 4th Quarter of 1983

Report on the ignition effectiveness tests in rich hydrogen-air-steam mixtures to be issued.

Completion of the supplemental tests to be completed with a supplemental report being issued during the 1st quarter of 1984.