R. Palla

March 19, 1984

MEMORANDUM FOR: T. Novak, Assistant Director
for Licensing, DL

FROM: R. W. Houston, Assistant Director
for Reactor Safety, DSI

SUBJECT: LICENSE CONDITIONS FOR CATAWBA, UNIT 1
DOCKET #50-413

As a result of our ongoing reviews on Catawba, we recommend that the Catawba Unit 1 operating license include the following license conditions:

Hydrogen Control Measures (II.B.7)

1. Before initial criticality, the distributed ignition system for hydrogen control shall be installed and operable, and shall be activated upon a safety injection signal.

2. Prior to full power licensing, upgraded analyses shall be completed to resolve the following issues:

   a) thermal response of the containment atmosphere and essential equipment for a spectrum of accident sequences using revised heat transfer models;

   b) effects of upper compartment burns on the operation and survival of air return fans and ice condenser doors.

Revised Main Steam Line Break Analysis (Section 6.2.1.1, SER)

Prior to initial criticality, a revised main steam line break analysis acceptable to the Commission shall be completed, using a revised heat transfer model accounting for additional heat transfer to steam during tube bundle uncovery in the steam generator.

The rationale for including the second item under Hydrogen Control Measures is provided in the enclosure to this memo.

8404050349

R. W. Houston, Assistant Director
for Reactor Safety
Division of Systems Integration

Enclosure:
As stated

Contact: R. Palla, CSB, X24762

cc: See next page

OFFICE	CSB:DSI	CSB:DSI	CSB:DSI	AD:RS:DSI
SURNAME	RPalla:mn	JShapaker	WButler	RWHouston
DATE	3/ /84	3/ /84	3/ /84	3/ /84

T. Novak

cc: R. Mattson
W. Butler
C. Tinkler
H. Oyksuoger
R. Pakka
K. Babbour
H. Garg

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CSB Rdg. File
RPalla
JShapaker
RWHouston
WButler

OFFICE							
SURNAME							
DATE							

PROPOSED LICENSE CONDITION REGARDING HYDROGEN CONTROL MEASURES FOR CATAWBA, UNIT 1

As a result of our ongoing review of hydrogen control matters for LWRs, the Containment Systems Branch recommends that the operating license for Catawba include the following license condition regarding Hydrogen Control Measures (Item II.B.7):

Prior to full power licensing, upgraded analyses shall be completed to resolve the following issues:

a) thermal response of the containment atmosphere and essential equipment for a spectrum of accident sequences using revised heat transfer models.

b) effects of upper compartment burns on the operation and survival of air return fans and ice condenser doors.

The first proposed license condition stems from the staff's ongoing review of the CLASIX containment code used for degraded core accident analyses and recent results of confirmatory analyses performed by Sandia. As part of the CLASIX code review, CSB requested clarification of the structural heat sink heat transfer models used in the CLASIX containment code. The following pertinent points have been derived from the utility responses:

- Heat transfer is at all times based on a temperature difference determined by (T_{bulk} - T_{wall}).

- Heat transfer coefficients for degraded core accident analysis are determined from a natural convection (stagnant) correlation applicable to condensation heat transfer, even when $T_{wall} > T_{sat}$.

- CLASIX does not model mass removal from the atmosphere due to condensation heat transfer.

Based on the description of the CLASIX structural heat sink model, it appears that the CLASIX model differs dramatically from generally accepted approaches and is not, as is claimed, consistent with standard methods such as those used in CONTEMPT. The differences are related to the treatment of the three items cited above. By comparison, previously accepted approaches are characterized by the following:

- Heat transfer is based on (T_{sat} - T_{wall}), when the surface temperature of the heat sink is less than T_{sat}; i.e., $T_{wall} < T_{sat}$.

- Heat transfer coefficients are based on condensation only when $T_{wall} < T_{sat}$.

- Condensed mass removal is based on condensation heat transfer with provisions for revaporizing a small fraction of the condensate.

The effect of the CLASIX models would appear to be the de-superheating of the atmosphere too rapidly thus reducing gas temperatures and possibly altering the combustion characteristics. The reduction of gas temperatures due to these modeling deficiencies is non-conservative since the thermal response of essential equipment is independently evaluated based on the containment temperature profile. As a result, CLASIX atmosphere temperature calculations and corresponding equipment response analysis may include smaller safety margins then were previously thought to exist.

The net effect of CLASIX model differences on the containment thermal response is not easily quantified since each aspect appears to be important only during certain portions of the transient. Specifically, the use of T_{bulk} rather than T_{sat} in the Uchida correlation results in greater calculated rates of heat transfer from the atmosphere to the heat sinks. The difference is most significant during hydrogen burns, which time T_{bulk} typically exceeds $1000^{O}F$ while T_{sat} remains below $300^{O}F$. Similarly, the use of heat transfer coefficients applicable to the condensing mode of heat transfer at times when condensation is not expected to occur (for $T_{wall} \geq T_{sat}$) results in calculated heat transfer rates at those times that are approximately an order of magnitude too high. Our confirmatory analyses indicate that the use of condensing heat transfer coefficients is appropriate over only a limited portion of the degraded core transient.

Finally, and perhaps most significantly, failure to remove condensate from the atmosphere, while continuously transferring energy to the heat sinks at a rate corresponding to condensation tends to drive the atmosphere towards saturation when it would otherwise remain superheated.

Thus, it is the view of the staff that the licensee should perform revised thermal analyses to address the aforementioned CLASIX modeling deficiencies, and supplement these analyses with revised equipment response calculations to demonstrate survivability for a spectrum of accidents.

The requirement to reassess equipment response for a spectrum of accidents and evaluate air return fan operation/survivability is prompted by the results of recent HECTR ice condenser analyses performed by Sandia as part of the RES Hydrogen Combustion Behavior and Hydrogen Burn Survival programs (References 1 & 2). Results of these programs, as documented in Reference 2 are being forwarded to all Atomic Safety and Licensing Boards presiding over ice condenser plants.

As part of the Sandia work, degraded core accident analyses were carried out using two different steam and hydrogen release schedules. The first set of release rates was the same as used by ice condenser utilities support of their deliberate ignition systems; the second set was developed by Sandia using a more recent version of the MARCH code. Also, heat sinks simulating plant equipment were included in several compartments of the containment.

The HECTR analyses indicate that for certain variations of the S_2D degraded core sequence, equipment temperatures can exceed the qualification temperature. As a result of these findings, the staff believes that additional parameter analyses should be performed by the licensee to demonstrate equipment survival for a spectrum of accidents.

Furthermore, numerous upper compartment burns were predicted in the majority of the Sandia analyses, and suggest a somewhat greater likelihood of upper compartment burning than was indicated by previous analyses. Although the staff has reviewed to a limited extent the matter of air return for operation and survival for upper compartment burns as part of the Sequoyah and McGuire hydrogen control system reviews, we feel that a more detailed analysis and review of the matter of fan survivability is justified especially in light of the recent Sandia results. Additional analysis of the ice condenser door loads, failure modes, and failure consequences also needs to be performed as a result of the upper compartment burn issue.

REFERENCES

1. Camp, A. L., et. al., MARCH-HECTR Analysis of Selected Accidents in an Ice Condenser Containment, Second Draft Report, Sandia National Laboratories, November 1983.

2. Dandini, V. J., et al., HECTR Analysis of Equipment Temperature Responses to Selected Hydrogen Burns in an Ice Condenser Containment, Draft Report, Sandia National Laboratories, February 1984.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

May 8, 1984

(S)

RP

Docket Nos: 50-413
and 50-414

Mr. H. B. Tucker, Vice President
Nuclear Production Department
Duke Power Company
422 South Church Street
Charlotte, North Carolina 28242

Dear Mr. Tucker:

Subject: Requests for Additional Information - Catawba Nuclear Station

As part of the NRC staff's review of hydrogen control for degraded core accidents in ice condenser plants, the staff has identified the need for additional information in this area (Enclosure 1). Enclosure 2 is a request for additional information regarding the financial qualification of Duke Power Company and other owners of Catawba Units 1 and 2. Furthermore, the staff has performed a preliminary review of your submittal transmitted by letter dated February 29, 1984, regarding leak before break for Catawba Unit 2 pressurizer surge line. Enclosure 3 is a request for additional information related to that area.

In order for the NRC staff to review, in a timely manner, your responses to the above issues, which have previously been discussed with your staff, we request that you provide your responses no later than May 25, 1984. If you require any clarification of this matter, please contact the project manager, Kahtan Jabbour, at (301) 492-7800.

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

Sincerely,

Elinor G. Adensam

Elinor G. Adensam, Chief
Licensing Branch No. 4
Division of Licensing

Enclosures:
As stated

cc: See next page

~~8405210425~~ 17pp

C/4

CATAWBA

Mr. H. B. Tucker, Vice President
Nuclear Production Department
Duke Power Company
422 South Church Street
Charlotte, North Carolina 28242

cc: William L. Porter, Esq.
Duke Power Company
P.O. Box 33189
Charlotte, North Carolina 28242

J. Michael McGarry, III, Esq.
Bishop, Liberman, Cook, Purcell
and Reynolds
1200 Seventeenth Street, N.W.
Washington, D. C. 20036

North Carolina MPA-1
P.O. Box 95162
Raleigh, North Carolina 27625

Mr. F. J. Twogood
Power Systems Division
Westinghouse Electric Corp.
P.O. Box 355
Pittsburgh, Pennsylvania 15230

Mr. J. C. Plunkett, Jr.
NUS Corporation
2536 Countryside Boulevard
Clearwater, Florida 33515

Mr. Jesse L. Riley, President
Carolina Environmental Study Group
854 Henley Place
Charlotte, North Carolina 28208

Richard P. Wilson, Esq.
Assistant Attorney General
S.C. Attorney General's Office
P.O. Box 11549
Columbia, South Carolina 29211

Mr. Pierce H. Skinner
Route 2, Box 179N
York, South Carolina 29745

North Carolina Electric Membership
Corp.
3333 North Boulevard
P.O. Box 27306
Raleigh, North Carolina 27611

Saluda River Electric Cooperative,
Inc.
207 Sherwood Drive
Laurens, South Carolina 29360

Mr. Peter K. VanDoorn
Route 2, Box 179N
York, South Carolina 29745

James P. O'Reilly, Regional Administrator
U.S. Nuclear Regulatory Commission,
Region II
101 Marietta Street, Suite 3100
Atlanta, Georgia 30303

Robert Guild, Esq.
P.O. Box 12097
Charleston, South Carolina 29412

Palmetto Alliance
2135 ½ Devine Street
Columbia, South Carolina 29205

Karen E. Long
Assistant Attorney General
N.C. Department of Justice
P.O. Box 629
Raleigh, North Carolina 27602

cc: Spence Perry, Esquire
Associate General Counsel
Federal Emergency Management Agency
Room 840
500 C Street, S.W.
Washington, D. C. 20472

Mark S. Calvert, Esq.
Bishop, Liberman, Cook,
Purcell & Reynolds
1200 17th Street, N.W.
Washington, D. C. 20036

REQUEST FOR ADDITIONAL INFORMATION

1. With regard to the CLASIX code, the staff has previously requested clarification of the structural heat sink heat transfer models. The following pertinent points have been derived from the responses:

   i) Heat transfer is based on a temperature difference determined by (T_{bulk} - T_{wall}).

   ii) Heat transfer coefficients for degraded core accident analysis are determined from a natural convection (stagnant) correlation applicable to condensation heat transfer.

   iii) CLASIX does not explicitly model mass removal due to condensation heat transfer.

   Based on the description of the CLASIX structural heat sink model, it appears that the CLASIX model differs dramatically from generally accepted approaches and is not, as is claimed, consistent with standard methods such as those used in CONTEMPT. The differences are related to the treatment of the three items cited above. By comparison, previously accepted approaches are characterized by the following:

   i) Heat transfer is based on (T_{sat} - T_{wall}), when the surface temperature of the heat sink is less than T_{sat}; i.e., $T_{wall} < T_{sat}$.

ii) Heat transfer coefficients are based on condensation only when $T_{wall} < T_{sat}$.

iii) Condensed mass removal is based on condensation heat transfer with provisions for revaporizing a small fraction of the condensate.

A more detailed description of accepted practice is contained in NUREG-0588 and NUREG/CR-0255.

The effect of the CLASIX models would appear to be the de-superheating of the atmosphere too rapidly thus reducing gas temperatures and possibly altering the combustion characteristics.

Considering the above discussion, provide the results of analyses, with acceptable models. to determine the effectiveness of deliberate ignition for the Catawba plant. The analyses should address the effects of hydrogen combustion on containment integrity and equipment survivability. Furthermore, the analyses should be performed to address a spectrum of appropriate degraded core accidents. Specific items that should be addressed include:

a. Model input and analytical assumptions;

b. Calculated compartment atomsphere pressure, temperature, and gas concentration transients;

c. Equipment temperature response profiles;

d. Differential pressure transients between compartments which will allow for an evaluation of ΔP effects on interior structures and mechanical components (e.g. doors, fans) ; and

e. Considering the capability of the containment shell, crane wall, and the operating deck, perform an analysis to determine the maximum concentration of hydrogen which could be accommodated in a deflagration. Your estimate should consider realistic initial conditions and approximate combustion parameters.

2. Provide a complete evaluation of fan (both air return and hydrogen skimmer as applicable) operability and survivability for degraded core accidents. In this regard discuss the following items:

a. The identification of conditions which will cause fan overspeed, in terms of differential pressure and duration, and hydrogen combustion events.

b. The consequences of fan operation at overspeed conditions. The response should include a discussion of thermal and overcurrent breakers in the power supply to the fans, the setpoints and physical locations of these devices, and the fan loading conditions required to trip the breakers.

c. Indication to the operator of fan inoperability, corrective actions which may be possible, and the times required for operators to complete these actions.

d. The capability of fan system components to withstand differential pressure transients (e.g., ducts, blades, thrust bearings, housing), in terms of limiting conditions and components.

3. Provide an analysis of the pressure differential loading on the ice condenser doors created by hydrogen combustion in the upper plenum and upper compartment. Describe and justify the assumed or calculated door positions. Provide an evaluation of the ultimate capability of the ice condenser doors to withstand reverse differential pressures. Discuss the probable failure modes and the consequences of such failures; including the impact on a) adjacent equipment and structures, b) ice bed integrity, and c) flow maldistribution.

4. Identify the essential equipment needed to function during and after a degraded core accident. Provide the location inside containment for this equipment.

5. In view of the recent TVA test results with Tayco igniters which indicate desirability of additional spray shielding, please discuss whether supplementary spray shields may be appropriate for the glow plug igniters.

REQUEST FOR FINANCIAL INFORMATION OPERATING LICENSES

1. a. Indicate the estimated annual cost by year to operate each unit of the subject facility for the first five full years of each unit's commercial operation. The types of costs included in the estimates should be indicated and include (but not necessarily be limited to) operation and maintenance expense (with fuel costs shown separately), depreciation, taxes and a reasonable return on investment. (Enclosed is a form which should be used for each unit for each year of the five year period.) Indicate the projected plant capacity factor (in percent) for each unit during each of the five years. Provide separate estimates using 50 percent and 60 percent plant capacity factors.

   b. Indicate the unit price per kWh experienced by each applicant on system-wide sales of electric power to all customers for the most recent 12-month period.

2. Indicate the estimated costs of permanently shutting down each unit of the facility (decommissioning costs), stating what is included in such costs, the assumptions made in estimating the costs, the type of shutdown contemplated, and the intended source of funds to cover these costs.

3. Provide an estimate of the annual cost to maintain each unit of the shutdown facility in a safe condition. Indicate what is included in the estimate, assumptions made in estimating costs, and the intended source of funds to cover these costs.

4. Have future decommissioning costs for any nuclear and/or non-nuclear facility owned by the applicant been collected through rates during the useful life of the facility? If so, cite specific examples and describe the methodology used for inclusion in rates. Provide the citation and relevant excerpts from any regulatory decisions allowing such decommissioning cost recovery. Indicate the total amount of decommissioning funds accumulated thus far, if any.

5. If the facility is jointly-owned provide copies of the joint participation agreement setting forth the procedures by which the applicants will share operating expenses and decommissioning costs.

THE FOLLOWING FINANCIAL INFORMATION IS REQUIRED FOR EACH INVESTOR-OWNED PARTICIPANT:

6. Provide copies of the prospectus for the company's most recent security issue and copies of the most recent SEC Form 10-K and 10-Q. Provide copies of the preliminary prospectus for any pending security issue.

7. Describe aspects of its regulatory environment including, but not necessarily limited to, the following: prescribed treatment of construction work in progress and allowance for funds used during construction; rate base (original cost, replacement, fair value, other); accounting for deferred income taxes and investment tax credits; fuel adjustment clauses in effect or proposed; historical, partially projected, or fully projected test year.

8. Provide citations and relevant excerpts from state and/or Federal statutes, rules or regulations (if any) that designate and require regulatory authorities to establish rates such that the applicant may recover all reasonable costs of operation incurred in the providing of utility service to customers. Also provide the citations and relevant excerpts from any administrative rulings or court decisions interpreting such statutes, rules, or regulations in the establishing of rates to allow recovery of costs incurred in the providing of utility service.

9. Describe the nature and amount of its most recent rate relief action(s). In addition, indicate the nature and amount of any pending rate relief action(s). Use the attached form to provide this information. Provide copies of the submitted, financially related testimony and exhibits of the staff and company in the most recent rate relief action or pending action. Furnish copies of the hearing examiner's report and recommendation, and final opinion last issued with respect to each participant, including all financially related exhibits referred to therein.

10. Complete the enclosed form entitled, "Financial Statistics," for the most recent twelve-month period and for the previous three calendar years.

ATTACHMENT FOR ITEM NO. 1.a.

ESTIMATED ANNUAL COST OF OPERATING NUCLEAR GENERATING UNIT: ______________
FOR THE CALENDAR YEAR 19__

(thousands of dollars)

Operation and maintenance expenses	
Nuclear power generation	
Nuclear fuel expense (plant factor ______%)	$______
Other operating expenses	______
Maintenance expenses	______
Total nuclear power generation	______
Transmission expenses	______
Administrative and general expenses	
Property and liability insurance	______
Other A.&G expenses	______
Total A.&G expenses	______
TOTAL O&M EXPENSES	______
Depreciation expense	______
Taxes other than income taxes	
Property taxes	______
Other	______
Total taxes other than income taxes	______
Income taxes - Federal	______
Income taxes - other	______
Deferred income taxes - net	______
Investment tax credit adjustments - net	______
Return (rate of return: ________%)	______
TOTAL ANNUAL COST OF OPERATION	$______

ATTACHMENT FOR ITEM NO. 9

RATE DEVELOPMENTS

Granted	Electric	Gas	Steam
Test year utilized			
Annual amount of revenue increase requested - test year basis (000's)			
Date petition filed			
Annual amount of revenue increase allowed - test year basis (000's)			
Percent increase in revenues allowed			
Date of final order			
Effective date			
Rate base finding (000's)			
Construction work in progress included in Rate base (000's)			
Rate of return on rate base authorized			
Rate of return on common equity authorized			

Revenue Effect (000's)	Electric	Gas	Steam
Amount received in year granted			
Amount received in subsequent year (If not available, annualize amounts received in year granted)			

Pending Requests	Electric	Gas	Steam
Test year utilized			
Amount (000's)			
Percent increase			
Date petition filed			
Date by which decision must be issued			
Rate of return on rate base requested			
Rate of return on common equity requested			
Amount of rate base requested			
Amount of construction work in progress requested for inclusion in rate base			

ATTACHMENT FOR ITEM NO. 10
FINANCIAL STATISTICS

12 months' ended

(dollars in millions)

Earnings available to common equity
Average common equity
Rate of return on average common equity

Times total interest earned before FIT:
Gross income (both including and excluding AFDC) + current and deferred FIT ÷ total interest charges + amortization of debt discount and expense

Times long-term interest earned before FIT:
Gross income (both including and excluding AFDC) + current and deferred FIT ÷ long-term interest charges + amortization of debt discount and expense

Bond ratings (end of period)
Standard and Poor's
Moody's

Times interest and preferred dividends earned after FIT:
Gross income (both including and excluding AFDC) ÷ total interest charges + amortization of debt discount and expense + preferred dividends

AFUDC
Net income after preferred dividends
%

Market price of common
Book value of common
Market-book ratio (end of period)*

Earnings avail. for common less AFDC + depreciation and amortization, deferred taxes, and invest. tax credit adjust.-deferred
Common dividends
Ratio

Short-term debt
Bank loans
Commercial paper

Capitalization (Amount & Percent)
Long-term debt
Preferred stock
Common equity

* If subsidiary company, use parent's data.

REQUEST FOR FINANCIAL INFORMATION
OPERATING LICENSES COOPERATIVE APPLICANTS

1. Is each participant's percentage ownership share in the facility equal to its percentage entitlement in the electrical capacity and output of the plant? If not, explain the difference(s) and any resultant effect on any participant's obligation to provide its share of operating costs.

2. Describe the rate-setting authority and rate convenants of the cooperatives and how that authority will be used to ensure the satisfaction of financial obligations in relation to operation and eventual permanent shutdown (decommissioning) of the facility.

3. Provide citations and relevant excerpts from state and/or Federal statutes, rules or regulations (if any) that designate and require regulatory authorities or the applicant itself to establish rates such that the applicant may recover all reasonable costs of operation incurred in the providing of utility service to customers. Also provide the citations and relevant excerpts from any administrative rulings or court decisions interpreting such statutes, rules, or regulations in the establishing of rates to allow recovery of costs incurred in the providing of utility service.

4. Have future decommissioning costs for any nuclear and/or non-nuclear facility owned by the applicant been collected through rates during the useful life of the facility? If so, cite specific

examples and describe the methodology used for inclusion in rates. Provide the citation and relevant excerpts from any regulatory decisions allowing such decommissioning cost recovery.

5. Describe the nature and amount of the cooperative's most recent rate relief action(s) and its anticipated effect on net margins. In addition, indicate the nature and amount of any pending rate relief action(s).

6. If membership cooperatives are involved, explain the contractual arrangements between the cooperative and its members that will provide funds for operation and eventual permanent shutdown (decommissioning) of the facility. Provide representative copies of such contracts.

7. Provide copies of the latest annual and interim financial statements. Also provide copies of similar statements for the corresponding periods ended in the previous year.

CATAWBA NUCLEAR STATION
MATERIALS ENGINEERING BRANCH
REQUEST FOR ADDITIONAL INFORMATION

1. Paragraph 5.2 on page 5-2 of Reference (a) below states that the pipe is subjected to internal pressure and an axial load (underlining added). Similar statements appear elsewhere in the report, however, other information presented indicates that the axial force due to pressure is included in the axial load. Please clarify.

2. The paragraph at the top of page 3-2 of Reference (a) below identifies the weld connection between the surge line and the pressurizer nozzle as being the limiting location to be analyzed. Figure 7-2, page 7-12, is a schematic drawing of this location. Provide the materials properties for the weldment as well as for the base metal, preferably in the form of a J-resistance plot. State the maximum value of J-material to be considered in your analyses and your basis for it.

References: (a) Westinghouse Report WCAP-10487 (Enclosure A to the February 29, 1984, letter) "Technical Basis for Eliminating Pressurizer Surge Line Ruptures as the Structural Design Basis for Catawba Units 1 and 2", February 10, 1984, proprietary.

(b) Westinghouse Report WCAP-10488 (Enclosure B to the February 29, 1984, letter) "Technical Basis for Eliminating Pressurizer Surge Line Ruptures as the Structural Design Basis for Catawba Units 1 and 2", February 10, 1984, non-proprietary.