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October 8, 1984

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Ms. E. G. Adensam, Chief
Licensing Branch No. 4

Re: Catawba Nuclear Station
Docket Nos. 50-413 and 50-414

Dear Mr. Denton:

On September 28, 1984, representatives from Duke Power Company, Westinghouse Electric Corporation and the NRC Staff met at the NRC's office in Bethesda, Maryland to discuss Proposed License Condition 14b which concerns the main steam line break (MSLB) in the Doghouse. The purpose of this letter is to provide a summary of the justification for interim operation of Catawba Unit 1 pending the Staff's review of MSLB's outside containment.

An analysis of a MSLB in the Doghouse was submitted to NRC/Region II on September 4, 1984 and was discussed at the September 28, 1984 meeting. That analysis was based on conservative "worst case" conditions. Analysis of the effects of different break sizes had been performed which demonstrated that all safety functions required to mitigate the MSLB were completed prior to the atmospheric temperature exceeding the qualification temperature of the equipment in the Doghouse.

A more realistic analysis has been now performed which demonstrates substantial additional time margins between completion of the equipment safety function and the time at which the Doghouse atmospheric temperature exceeds the qualification temperature. This revised analysis is discussed in Attachment 1. A discussion of the sensitivity of the analysis to break size and power level is included in Attachment 2. Attachment 3 presents a discussion related to the specific doghouse equipment needed to mitigate an MSLB in either of the Catawba Doghouses.

As requested by the Staff during the September 28, 1984 meeting, a review of the effect of a MSLB in the Doghouse on control and power circuits has been performed and is included in Attachment 4.

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As further justification, Westinghouse has performed a preliminary fracture mechanics evaluation to determine a maximum crack opening area for a MSLB. This evaluation concluded that tube bundle uncovery would not occur and therefore the original equipment qualification temperature envelopes would not be exceeded. This evaluation is described in Attachment 5.

Based on the justifications noted above and a more realistic analysis which demonstrates substantial additional time margins, it is concluded that plant safety would not be adversely affected in the event of a MSLB in the Doghouse and that qualification of the required Doghouse equipment has been demonstrated.

Very truly yours,

Hal B. Tucker

Hal B. Tucker

RWO:slb

Attachment

cc: Mr. James P. O'Reilly, Regional Administrator
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ATTACHMENT 1

Catawba Nuclear Station

EVALUATION OF MSLB IN DOGHOUSE UTILIZING BEST ESTIMATE ANALYSIS

The Doghouse MSLB, as discussed in the September 28, 1984 meeting with the NRC staff, was based on conservative "worst case" conditions. Analysis of the effects of different break sizes had been performed which demonstrated that all safety functions required to mitigate the MSLB were completed prior to the atmospheric temperature exceeding the qualification temperature of the equipment in the Doghouse.

However, questions were raised by NRC staff concerning the time margin between completion of the equipment safety function and the time at which the Doghouse atmospheric temperature exceeds the qualification temperature. The following information is provided to show that when utilizing a more realistic analysis and taking into account equipment temperature/time lag, substantial additional time margin can be demonstrated.

In order to provide an indication of the conservatism of the original analysis results, Westinghouse performed a better estimate analysis (with some conservatisms maintained) on the limiting break size and power level determined from a spectrum of break size and power level combinations.

The assumptions which were modified in order to provide a comparison to the original report are indicated below:

a. Nominal initial conditions without error allowances

b. 1% additional control rod reactivity is inserted beyond that assumed in the original analysis. (Previously it was assumed the most reactive Rod Cluster Control Assembly remains in its fully withdrawn position.)

c. 100% ANS decay heat rather than 120% ANS decay heat.

d. Nominal safety actuation setpoints for Low Steamline Pressure and Low Pressurizer Pressure signals.

e. Feedwater isolation is assumed to occur eleven seconds after reactor trip signal and coincident with Low-Low T_{avg} function.

f. Auxiliary feedwater flowrates are defined as a function of steam generator pressures for the Catawba plant. The previous analysis used flowrates which were lower than the actual Catawba values to provide conservatism. A failure of the turbine driven AFW pump is still assumed in order to conservatively limit mass addition to the steam generators.

g. Best estimate safety injection flowrates.

h. A more realistic initial atmospheric temperature in the Doghouse was used, $120^{o}F$ rather than $135^{o}F$.

i. Better estimates for steel surface areas in the heat transfer model were used, as the original values were approximately three times too low and thus conservative.

In this revised analysis, the time at which the atmospheric temperature in the Doghouse exceeds $340^{o}F$ was generated for a 0.5 ft^2 break at 70% power, (which was determined to be the worst break) and is presented in Table I. Also in Table I, for comparison

purposes is the corresponding information from the conservative analysis discussed at the September 28, 1984 meeting.

The time versus temperature analysis was conducted for breaks in compartments 1 and 3 of the doghouse (See Figure 1). Compartments 1 and 3 were chosen because they contain the safety related equipment required to mitigate the MSLB.

Mainsteam isolation has been determined, by analysis, to be the limiting safety function, i.e., the last function to be completed in this accident scenario. Mainsteam line isolation is completed at 360 seconds (6.0 min) and the Doghouse atmospheric temperature exceeds 340°F in compartment 3 (MSIV's location) at 445 seconds (7.4 min.) for a MSLB in compartment 3. Therefore, the revised analysis yields a time margin of 85 seconds (1.4 min.) as compared to 16 seconds (.3 min.) of the previous, conservative analysis.

In addition to the margin available in the revised analysis, temperature/time lag for the equipment has also been evaluated. A temperature/time lag calculation for a Valcor solenoid valve has been conducted. The Valcor solenoid valve was chosen for the heat transfer calculation due to its small mass and relatively large surface area. These physical parameters make it most sensitive to temperature rise as compared to the other safety equipment located in the Doghouse such as the MSIV solenoids. Both convection and radiative components of heat transfer were included in the analysis. Calculation results show that the solenoid coil (critical component) temperature lags behind the atmospheric temperature by approximately 4.3 minutes. Conservatively applying the 4.3 minutes temperature/time lag to the MSIV solenoid and, combining the time margin provided by the best estimate analysis above, the MSIV's will have completed their safety function 5.7 minutes prior to its critical components experiencing a temperature in excess of its qualification temperature.

Based on the above margin along with consideration of a spectrum of breaks, a determination that the Doghouse equipment is not required to reposition later in the event, and that failure of the Doghouse equipment after its safety function is not detrimental to plant safety, it is concluded that qualification of the required Doghouse equipment has been further demonstrated.

TABLE I

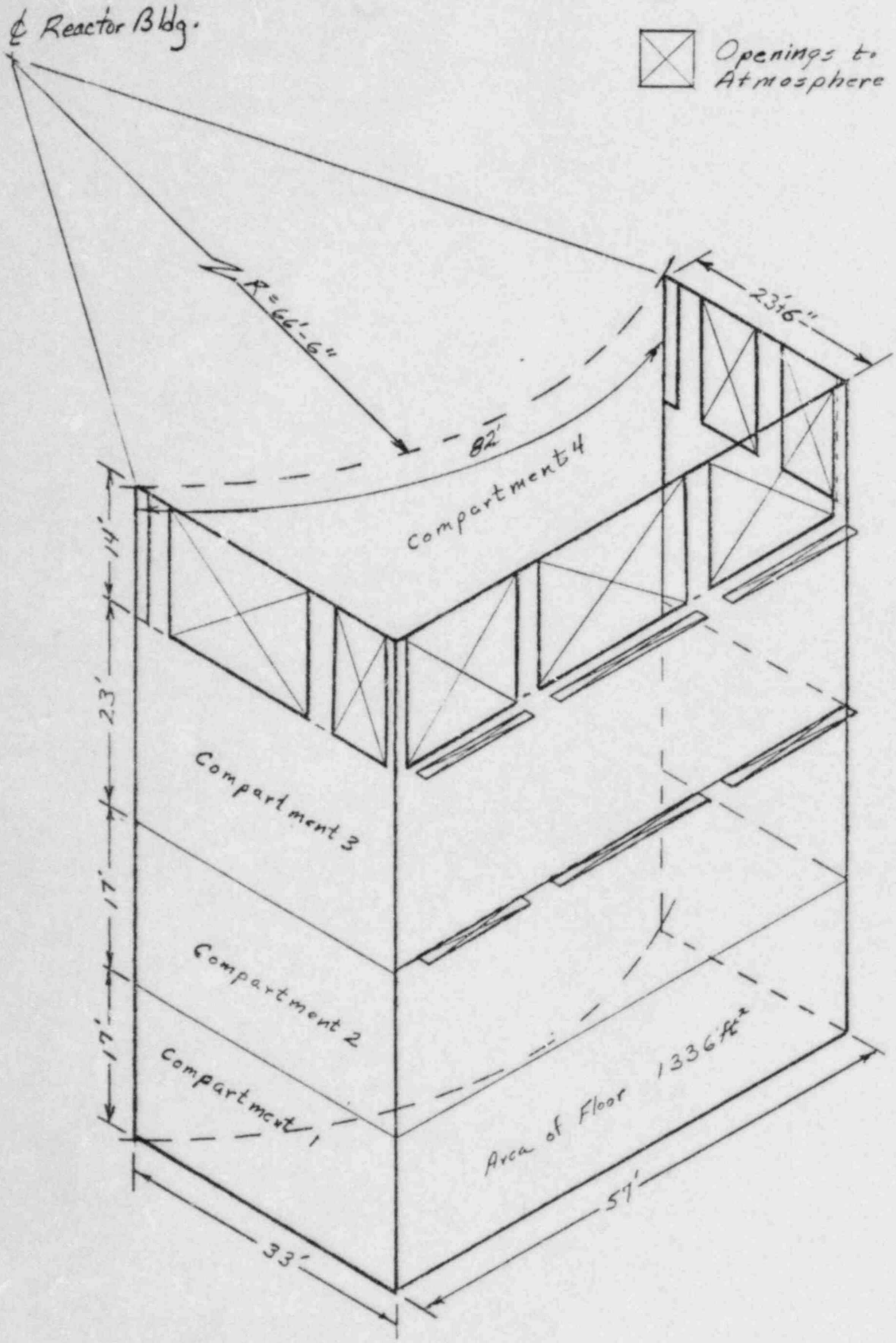
REVISED ANALYSIS
TIME AT WHICH ATMOSPHERIC TEMPERATURE EXCEEDS 340°F

Break in Compartment 1		Break in Compartment 3	
Compartment 1 Time	Compartment 3 Time	Compartment 1 Time	Compartment 3 Time
430 sec. (7.2 min.)	450 sec. (7.5 min.)	Temperature does not exceed 340°F (T_{peak} = 275°F @ ∼ 725 sec.)	445 sec. (7.4 min.)

PREVIOUS CONSERVATIVE ANALYSIS
TIME AT WHICH ATMOSPHERIC TEMPERATURE EXCEEDS 340°F

Break in Compartment 1		Break in Compartment 3	
Compartment 1 Time	Compartment 3 Time	Compartment 1 Time	Compartment 3 Time
335 sec. (5.6 min.)	360 sec. (6.0 min.)	Temperature does not exceed 340°F (T_{peak} = 255°F @ ∼ 490 sec.)	355 sec. (5.9 min.)

FIGURE 1



Typical Doghouse Structure

Attachment 2

Catawba Nuclear Station

WORST CASE RESULTS FOR MSLB DOGHOUSE ANALYSIS

The Westinghouse portion of the MSLB Doghouse analysis determined results for a spectrum of over 60 break size and power level combinations with assumptions which were, in all cases, conservative for the Catawba plant. Westinghouse and Duke jointly determined from these results that the worst case for the safety actuation study is the 0.5 ft^2 break at a 70% power level. It is possible that a small variation in power level (e.g., $\pm$ 3%) could produce slightly smaller actuation margins. However, the magnitude of the margins demonstrated herein utilizing the best estimate analysis (e.g., 85 seconds between the time when all valves have aligned to their proper position and the time at which equipment qualification temperatures are exceeded) more than compensate for any decrease in margin due to power level variation. In addition, thermal lag in the equipment provides still more margin as discussed in Attachment 1.

Attachment 3

Discussion of Class 1E
Doghouse Equipment Required for Steamline
Break Outside Containment

I. Criteria Used to Identify Required Equipment

1. Steam Generator (SG) overfill should be prevented.

2. Adequate auxiliary feedwater must be supplied automatically to at least one steam generator to allow adequate operator action time to isolate faulted SG and realign to intact SG.

3. SG pressure boundary must be maintained to prevent loss of feedwater and to prevent overcooling.

II. 1E Equipment Locations

See Section IV for a list of all Class 1E valves and instrumentation located in the Doghouses. Auxiliary Feedwater Pump Turbine Steam Supply Isolation Valves are located in the interior doghouse only. All other valve types are located in both interior and exterior doghouse.

III. 1E Doghouse Equipment Required

1. Valves required to prevent SG overfill

SG overfill is prevented by tripping the main feedwater pumps and closing the pump discharge isolation valves (located in the Turbine Building) on a high steam generator level signal. In addition, feedwater control valves also located in the Turbine Building close on both a feedwater isolation signal and high steam generator level signal. Valves located in the doghouses are not required to prevent overfill but serve as a backup. These valves are the main feedwater isolation, tempering isolation, and feedwater supply to the upper nozzle.

2. Valves required to prevent loss of feedwater from the SG

CF87AB
CF88AB
CF89AB
CF90AB
— Feedwater purge isolation

BB147B
BB10B
BB148B
BB21B
BB149B
BB57B
BB150B
BB61B
— SG Blowdown isolation

Loss of feedwater is prevented through the tempering line and the feedwater supply line to the upper nozzle by two check valves in series in each flow path. Loss of feedwater is prevented through the main feedwater line by

one check valve and by closure of the feedwater control valve (located in the Turbine Building) on a feedwater isolation signal. The only flow path from the main feedwater line that requires closure of 1E valves in the Doghouse is the reverse purge line. Reverse purge isolation valves are fail closed air operated valves with redundant de-energize to close solenoids. Since the reverse purge lines are used only at low power, the valves will be normally closed. Non-safety grade motor operated valves located in the Turbine Building can also be used to isolate flow.

SG blowdown is isolated in each Doghouse by two valves in parallel lines outside containment and by one valve in the common line inside containment. In addition, blowdown is isolated in the Turbine Building by closing the non-safety blowdown control valves. All blowdown isolation valves close on automatic auxiliary feedwater pump start on a low-low steam generator level signal.

SG blowdown and reverse purge valves will close automatically before equipment qualification is exceeded.

3. Valves required to isolate to control cooldown

SM1AB, SM3AB, SM5AB, SM7AB — Main Steam Isolation Valve (MSIV)

SM9AB, SM10AB, SM11AB, SM12AB — Main Steam Isolation Bypass

SV1AB, SV7AB, SV13AB, SV19AB — Steam Generator PORV

The MSIV's, MSIV bypass valves and the SG PORV's are required to isolate the SG pressure boundary to control cooldown. Each valve is air operated fail closed, supplied with redundant normally energized solenoids that deenergize to close the valves. These valves receive a main steam isolation signal to close and will be closed before equipment qualification is exceeded. The SG PORV block valve is supplied with 1E power; however, since the SG PORV is qualified, the block valve is not required to close. Main Steam Low Point Drain Isolation is not required because lines are orificed to limit flow.

4. Valves required to supply auxiliary feedwater flow and isolate the faulted SG.

CA38A, CA42B, CA46B, CA50A, CA54B, CA58A, CA62A, CA66B	Auxiliary Feedwater Isolation
SA2AB	Auxiliary Feedwater Pump
SA5AB	Turbine Steam Supply

The motor driven (MD) and turbine driven (TD) auxiliary feedwater pumps are located in the feedwater pump room so they are not affected by the steamline break. The TD pump is not required for any steamline break. Assuming a single failure of one MD pump, adequate time is available for the operator to realign the other MD pump to supply flow to intact, steam generators.

The motor operated auxiliary feedwater isolation valves are normally open and are required to remain open to supply flow to the steam generators. The adverse environment will not cause the valves to spuriously close. Flow to the faulted SG can be isolated by closing the control valves located in the feedwater pump room, by closing manual isolation valves or by tripping the pumps that are not required.

5. Instrumentation

The only post-accident monitoring instruments located in the Doghouse are the auxiliary feedwater flow transmitters, which are not required to mitigate the consequences of a Doghouse MSLB. Although these may fail under this environment, post-accident monitoring of the auxiliary feedwater function can be accomplished by the steam generator level transmitters which will not be affected by a steamline break in the Doghouse.

Water level instrumentation in the Doghouses is not required to function in the event of a Doghouse MSLB.

IV. Class 1E Equipment Located in the Doghouses

Valve No.	Description	Type Operator
SM1AB SM3AB SM5AB SM7AB	Main Steam Isolation	Air Operated Valve (AOV)
SM9AB SM10AB SM11AB SM12AB	Main Steam Isolation Bypass	AOV
SV1AB SV7AB SV13AB SV19AB	Steam Generator PORV's	AOV
CF33AB CF42AB CF51AB CF60AB	Feedwater Isolation	Electro-Hydraulic Operated
CF87AB CF88AB CF89AB CF90AB	Feedwater Purge	AOV
CA149AB CA150AB CA151AB CA152AB	Feedwater Supply to Upper Nozzle	AOV
CA185AB CA186AB CA187AB CA188AB	Tempering Isolation	AOV
CA38A CA42B CA46B CA50A CA54B CA58A CA62A CA66B	Auxiliary Feedwater Isolation	Motor Operated Valve (MOV)

Valve No.	Description	Type Operator
SV25B SV26A SV27A SV28B	Steam Generator PORV Isolation	MOV
SM74B SM75B SM76B SM77A	Main Steam Low Point Drain Isolation	MOV
BB10B BB21B BB57B BB61B	Steam Generator Blowdown Isolation	MOV
BB147B BB148B BB149B BB150B	Steam Generator Blowdown Isolation Bypass	MOV
SA2AB SA5AB	Auxiliary Feedwater Pump Turbine Steam Supply Isolation	AOV

Instrument No.	Description
CAFE5090 CAFE5100 CAFE5110 CAFE5120	Auxiliary Feedwater Flow
CFLS6000 CFLS6030 CFLS6060 CFLS6090	Doghouse Water Level Transmitters

Attachment 4

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Review of Control and Power Circuits for Degradation

A review has been completed to evaluate the effects of a MSLB in the Doghouse on safety-related control systems exposed to the harsh environment. The following is a summary of the findings:

1. No safety-related cables are routed through a Doghouse which terminate at equipment located outside the Doghouse.

2. Equipment located in the Doghouse that is required to mitigate the effects of the MSLB was reviewed. This equipment was previously confirmed to be qualified to perform its safety function before qualification temperatures are exceeded. Further review was done to determine if component failures in the harsh environment could cause any valves to reposition that are required to stay in the safe position; No failures were identified that could cause any repositioning.

3. All safety-related control circuits in the Doghouses were reviewed to determine if any component failures could affect other safety-related circuits. All safety-related control components in the Doghouses are protected by separate fuses that are coordinated with upstream feeder breakers to avoid affecting any other related circuits.

Additionally, no failure mechanism which would degrade safety power was identified.

Attachment 5

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Preliminary Fracture Mechanics Evaluation

Currently, the environmental analysis for the MSLB in the Catawba Doghouses is performed by postulating non-mechanistic breaks in which catastrophic pipe failure is assumed. More realistic estimates of crack opening area and the resulting thermal and mechanical loads can be obtained through application of fracture mechanics techniques. A scoping study has been carried out by Westinghouse for in-containment MSLB's and preliminary results obtained indicate that a non-mechanistic pipe break will not occur in the main steam line.

The purpose of this scoping study was to show that a circumferential flaw larger than any that would be present in the main steam lines will remain stable when subjected to the worst combination of plant loadings. The flaw stability criteria for the analysis examined both the global and local stability. The global analysis was carried out using the plastic instability method, based on traditional plastic limit load concepts but accounting for strain hardening and taking into account the presence of a flaw. The local stability analysis was carried out for a postulated 10-inch long through-wall circumferential flaw. The objective of the local analysis was to show that unstable crack extension will not result for the postulated flaw. The crack opening area resulting from faulted load was calculated for the 10-inch flaw using simplified analysis techniques.

The following results were obtained from the above evaluation:

a. Limit moment calculations indicated that the critical flaw size (beyond which the flaw is unstable) would be greater than the pipe diameter.

b. A postulated 10-inch long through-wall circumferential flaw will remain stable when subjected to maximum faulted load of less than 20 ksi.

c. Available fatigue crack growth results for the main steam line of typical PWR plants indicate no significant crack growth due to design transients.

d. The crack opening area is estimated to be about 0.2 in^2 (0.001 ft^2). If a safety factor of 10 is used, the area would be about 2 square inches (0.01 ft^2).

From these results it is judged that it could be demonstrated by fracture mechanics analysis that catastrophic pipe breaks in the main steam line would not occur. Westinghouse systems evaluations have shown that for crack areas less than 0.1 ft^2, tube bundle uncovery will not occur. Therefore, no superheated steam would be generated and original equipment qualification temperature envelopes would not be exceeded.