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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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USNRC

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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In the Matter of DUKE POWER COMPANY, et al. (Catawba Nuclear Station, Units 1 and 2)	))))))	Docket Nos. 50-413 50-414

OFFICE OF SECRETARY DOCKETING & SERVICE BRANCH

CESG'S OPPOSITION TO APPLICANT AND STAFF MOTIONS FOR SUMMARY DISPOSITION OF CESG CONTENTION 18/PALMETTO 44

Applicant and NRC staff have filed motions for the summary disposition of CESG's Contention 18/Palmetto Alliance 44 (MA and MS respectively). These motions state both the contention as initially filed and as "clarified" by CESG and admitted by the Board. The sense of Contention 18 is that whether the Applicant observes or fails to observe the regulations pertaining to reactor embrittlament which are in effect there will be a hazard of reactor breach to which embrittlement will be a contributor.

CESG entreats the Board to scrutinize the pleadings in regard to meaning in the world of experience. Observance of a regulation will only give a satisfactory outcome if the regulation is adequate. Frequently, projected outcomes under regulation are represented as facts. Adequate regulations are not always observed. The thousands of LER's and hundreds of I and E Information Notices and Bulletins, Power Reactor Events, etc., demonstrate that it is one thing to prescribe an intent, another to realize it. In the present instance the question is, do the regulations give reasonable assurance that a Catawba reactor will not breach? Intervenor will seek to show that the although the regulatory language appears to provide this assurance, a close analysis of the factors entering into reactor breach indicates thts assurance is more apparent than real.

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CESG will address the alleged material facts asserted by Applicant and Staff; the several arguments; present material facts which do not support summary disposition and a discussion.

MATERIAL FACTS ALLEGED BY APPLICANT

Of material facts designated A through N by Applicant, CESG differs only with I and N.

I. Intervenors have not raised by affidavit or otherwise special circumstances of a "special safety significance" relating directly to Catawba that make a prima facie showing "that application of . . . [Appendices G and H of 10 CFR Part 50] would not serve the purposes for which . . . [they were] adopted." 10 CFR §2.758

Applicant objects to Intervenor's "challenge to the regulations," MA p. 10. There is indeed a special circumstance implicit in CESG's raising this matter of special safety significance. Reactor breach would have grave consequences, NUREG-2236, Table C-1, p. C-3. The assertion of this contention is, in the real world, CESG's one opportunity for a bite at the apple. It is beyond CESG's fiscal and other capabilities to raise a generic challenge to current embrittlement (or other) regulations. Catawba is the plant on our doorstep. The very special circumstance is that if we are to be able to raise valid technical concerns, which I believe we are able to do, concerning the Catawba plant it must be here and now and in the face of existing regulations.

N. Contrary to Intervenors' assertion, Section II C 3 a of Appendix H to 10 CFR Part 50, providing specimen capsule requirements for plants with estimated end-of-life reference temperature not exceeding 100°F, was not applicable to the Catawba pressure vessels.

Staff's response to Palmetto Interogatory 36, Dec. 15, 1982, states that the conditions of the subject section are met by the end of life adjusted reference temperatures for Catawba reactors.

These temperatures "will be less than limit conditions of Paragraph II C 3 a of Appendix H, 10 CFR Part 50." In a response to Palmetto Interogatory 25 of the same date Staff states that Catawba was constructed according to ASME codes dated 1971, 1972, 1967 and 1966. The 100°F RT_{NDT} was in effect during this period.

MATERIAL FACTS ALLEGED BY STAFF

Of material facts 1 through 20 as designated by Staff, CESG differs with nine as follows:

1. CESG Contention 18 (Palmetto 44) claims that a safety hazard exists at Catawba because: (1) the NRC's projection of the amount of increase in reference temperature RT_{NDT}, which results from neutron irradiation damage, is nonconservative, and (2) the amount of reactor material degradation for the reactor vessels cannot be accurately measured. Affidavit ¶2.

CESG contends that Staff has not demonstrated that it has a sufficient information base to assert whether an RT_{NDT} projection is conservative or not; that the poor agreement between several methods and the large variance assignable to individual values, the standard deviation with the Guthrie formula is 24; and the fact that the projected values apply to coupons rather than to the weakest spot in the reactor vessel make the projections not merely nonconservative, but worthless.

6. Comparison of the projections using Reg. Guide 1.99 and the test results from Oconee shows that the actual increase in reference temperature has been well below that predicted, and therefore there has been no "unanticipated 'rapid increase in reference temperature' . . ." at Oconee. Affidavit, ¶ 4.

Staff does not define the time at which it made the high prediction for the Oconee RT_{NDT}. Intervenor maintains that at the time of licensing Oconee, and of promulgating the version of Appendices G and H to 10 CFR Part 50 then in effect, the magnitude of actual increase at that reactor and others was unanticipated. The copper, nickel, phosphorus effect was not known.

11. Appendix H, 10 CFR, Part 50 requires that all commercially operated reactor vessels have samples from their limiting materials placed in capsules which are then irradiated and subsequently withdrawn according to a schedule and tested to determine the amount of reactor vessel material embrittlement resulting from neutron irradiation damage. Affidavit, ¶ 7.

It should be noted that Oconee capsules were irradiated at Crystal River, an exemption from the rule having been obtained. See Staff response to Palmetto Interogatory 35 a. and b. of Dec. 15, 1982. "The Oconee reactors surveillance programs are not in compliance with the in-vessel surveillance requirements of Appendix H, 10 CFR Part 50." Details of the exemption granted are provided.

Further if one takes the bond of the weld to the reactor plate to be the limiting material, the Appendix H requirement is not met in that it is neither exposed to irradiation nor tested.

14. The combination of prediction methods previously discussed and Applicant's reactor vessel surveillance program will accurately determine the amount of reactor material degradation for the Catawba reactor vessel materials. Affidavit, ¶ 7.

The Guthrie formula ascribes a standard deviation of $24^{\circ}F$ to the RT_{NDT} values it arrives at. To reach a 95% level of confidence, $48^{\circ}F$ are added to the calculated value. In a context were presumably at one time exceeding a $100^{\circ}F$ RT_{NDT} was the signal for an action, the uncertainty associated with actually calculated RT_{NDT} values is enormous. By no stretch of misuse of scientific parlance can accuracy be attributed to these measurements. The discrepancy between Reg. Guide 1.99 calculated RT_{NDT}'s and Guthrie formula values further repudiates the attribution of accuracy, see MS Table I in which the difference for Catawba Unit 2 is $32.5^{\circ}F$ exclusive of the contributions of variance.

15. The Staff ensures safe operation of the reactor vessel during normal, anticipated upset and test conditions by requiring the vessel to be operated within the operating limits of Appendix G, 10 CFR Part 50, which, in turn, are based upon the RT_{NDT} for the limiting reactor vessel material. Affidavit, ¶ 8.

The Staff does not refer to safe operation under accident conditions. During a range of LOCA events the ECCS can pressurize the reactor with relatively cool water, violating the operating limits in a way not subject to operator control. As a material fact this statement is misleading in that it misrepresents the ensuring of safe operation.

16. Since the Catawba reactor vessel materials will have their RT_{NDT} accurateĺy determined throughout the life of the plant, and the Staff will use the higher of the RT_{NDT} values produced by comparison of the projection methods and the surveillance program for calculating operating limit curves (augmented by a safety factor of 2) the reactor vessels can be safely operated during normal, upset and test conditions. Affidavit, ¶ 8.

The accuracy imputed to RT_{NDT} estimates is discussed in 14 foregoing. The omission of LOCA conditions is discussed in 15. The omission of the weld metal/reactor plate specimens from the irradiation capsule is discussed in 11. There is further, the absence of stress fatigue in the capsule specimens, a factor materially reducing the strength of the reactor vessel. Further still, every real structure has a weak spot as the result of an accumulation of faults. Capsule specimens in no way indicate the capability of the weak spot. The reliability of a safety factor of 2 has not been experimentally demonstrated.

17. The Staff ensures safe operation of the reactor vessel during faulted and emergency conditions by requiring the vessel RT_{NDT} to comply with the screening criteria of Commission Report SECY-82-465, "Pressurized Thermal Shock," which states that "the risk from PTS events for reactor vessels with RT_{NDT} values less than the proposed screening criteria (270°F for axial welds and 300°F for circumferential welds) is acceptable." Affidavit, ¶ 9.

There is no connection between safe operation during faulted and emergency conditions and compliance with RT_{NDT} screening criteria of 270°F for axial welds and 300°F for circumferential welds. Nor is there a rational response to this allegation. At best it appears to be a make-weight which includes a phrase pertaining to faulted

and emergency conditions.

19. The upperbound 95% confidence RT_{NDT} for Catawba Units 1 and 2 reactor vessels are 162°F and 124.5° F, respectively; these values are well below the PTS screening criteria and indicate that the risk to the vessel during faulted and emergency conditions is acceptable. Affidavit, ¶ 10.

Alleged material fact 19 depends on the validity of alleged material fact 18. As it is worthless, see foregoing, 19 is also worthless.

20. Since Appendix G vessel operating limits will be based upon accurate measurements of reactor material degradation and conservative methods of predicting such degradation, there is reasonable assurance that the Catawba reactor vessels can and will be operated well within acceptable safety margins for material degradation. Affadavit, ¶ 11.

As stated foregoing, the measurements of coupon degradation are not accurate. The material in the reactor is not monitored and is subject to stress fatigue as well as radiation damage. The weak spot is not identified nor quantified. The conclusion of reasonable assurance that the reactor will be operated "well within acceptable safety margins for material degradation" is not supported by the available data. And the potential for violating the limit curve under some LOCA conditions is ignored.

RELEVANT MATERIAL FACTS NOT ADVANCED BY APPLICANT OR STAFF

1. The inspection by the manufacturer, Klockner Werke A.G., represented the Oconee-1 reactor vessel as free of flaws. Applicant holds that a recent inspection of the reactor vessel revealed flaws, not cracks. Applicant's response to CESG Interogatory 1, April 26, 1983. Staff responds that "[f]law indications identified therein were reported to have been produced during fabrication of the reactor vessel." May 10, 1983 filing.

2. Changes in Oconee-1 reactor vessel have occurred during operation which, depending on word usage, are designated either cracks or flaws.

3. The NRC at the time of licensing Oconee units 1, 2, and 3 assumed the technical reasonableness of setting a limit to the end-of-life RT_{NDT} of $100^{\circ}F$.

4. The providing of six test specimen capsules for Catawba reactors is not an expression of confidence that the RT_{NDT} will not rapidly increase. For reactors in which it was expected the adjusted reference temperature at end of life would not exceed $100^{\circ}F$ three capsules were required; where it was expected that $200^{\circ}F$ would not be exceeded, four capsules were required; where $200^{\circ}F$ was expected to be exceeded, "at least five surveillance capsules shall be provided." Appendix H, 10 CFR 50, II 3 a, b, and c. Revision of Jan. 1, 1978.

5. The Catawba reactor vessels have required exemptions from 10 CFR 50 Appendix G Paragraphs III B 1, III B 4, III C 1, IV A 1, IV A 3, and IV B and Appendix H II C 3. SER 5.3.3. This includes the failing of vessel 1 to meet the reactor beltline material requirement of 75 foot pounds.

6. The Oconee reactor surveillance program is not in compliance with the requirements of Appendix H, 10 CFR 50. Staff response to Palmetto Interrogatory 35 b, Dec. 15, 1982. It is, instead, a member of a Babcock and Wilcox Owner's Group. The number of capsules initially placed, consistent with a lower RT_{NDT}, reflects an anticipation of a lower rate of increase in reference temperature than was actually experienced.

7. Reactor embrittlement has subsequently been perceived as a major problem. "There have been hundreds of studies, documents, technical reports and treatises and volumes of testimony dealing with the subject matter of embrittlement." Staff response to Palmetto Interrogatory 1, Dec. 15, 1982.

8. Investigation has disclosed that rapid embrittlement on irradiation of reactor vessel materials is associated with the levels of copper, nickel and phosphorus. Staff response to Palmetto Interrogatory 3, Dec. 15, 1982

9. The Staff believes that rapid embrittlement will not be a problem at Catawba because the concentrations of copper, nickel and phosphorus will be lower than at Oconee. Staff response to Palmetto Interrogatory 3, Dec. 15, 1982.

10. Not enough time has passed nor experience been accumulated to confirm Staff's belief (Staff's language: "The staff believes . . .").

11. The Staff has not used a well delineated nor uniform approach in its references to RT_{NDT}. A variety of methods is used to assay fracture toughness: Reg. Guide 1.99 method; Guthrie formula; "fracture mechanics approach." Response to Palmetto Interrogatory 21, Dec. 15, 1982.

12. "Reactor Vessel Materials Toughness" is Unresolved Safety Issue Task A-11. Staff response to Palmetto Interrogatory 21, Dec. 15, 1982.

13. Pressurized Thermal Shock is Unresolved Safety Issue A-49. SER 5.3.1.3.

14. Staff is not consistent in its interpretation and application of RT_{NDT}. It is a material property of an irradiated specimen. Response to CESG Interrogatory 3, May 18, 1983. But Staff also refers to the RT_{NDT} "at the vessel ID". Response to Palmetto Interrogatory 3, Dec. 15, 1982.

15. Capsules contain specimens of reactor plate material, of weld metal, but not of weld to plate. There is no testing of welds. In this context the weld is the interface between plate and weld metal.

16. The weld metal/reactor plate interfaces are a most likely site of flaws and a most likely region for flaw or crack initiation and propagation. It is the region wherein the attempt is made to bridge a discontinuity.

17. Reactor breach can be initiated by the propagation of a linear flaw or crack.

18. Crack propagation is the most likely mechanism of reactor breach and the concern of 10 CFR 50 Appendices G and H. None of the tests required under regulation deal with:

a) the reactor plate/weld metal interface
b) specimens experiencing fatigue representative of the cyclic heatup and cooldown of the reactor vessel for which they are a test surrogate.
c) fatigued specimens experiencing a stress gradient comparable to that of a reactor in various states, including cooldown or an out-of-limits LOCA cooldown.

19. Fatigue is a design determinant for reactor life. It is put at 200 cycles for the Catawba reactor. Staff response to CESG Interrogatory 7, May 10, 1983.

20. The stress level at the inner reactor vessel surface is critical in respect to crack (or linear flaw) growth and propagation. There is no test measuring this property for fatigued, irradiated reactor plate/weld metal interface under conditions of stress simulating rapid cooldown of a pressurized reactor, the critical case.

21. Applicant and Staff are not even in agreement in the simple matter of the effect of a notch on a stressed tensile specimen, Applicant holding that the notch increases stress concentration, Staff holding that it decreases it. Responses to CESG Interrogatory

11. Nor do they agree as to the response to notching. CESG Interrogatory 10. Nor on the failure stress levels of notched and cracked materials. Interrogatory 12.

22. The high variance in a series of Charpy V-notch samples is reflected in the high variance of the adduced values of RT_{NDT}. In science and engineering, high precision signifies low variance. Accuracy denotes both correctness and precision. The standard deviation of a group of replicate measurements provides a characterization of variance. The standard deviation for the Guthrie formula derivations of RT_{NDT} is said to be 24°F. In a technology in which a precision of less than 1°F is commonly obtained, a 24°F standard deviation is incompatible with the Staff's claims of "accurate measurements". MS 20.

23. None of the tests prescribed by regulation take place near the temperature of an operating reactor vessel, about 600°F. The tensile properties of reactor materials are known to decrease with increase in temperature. ASME Boiler and Pressure Vessel Code, Section 3, Appendix I-Stress Tables.

DISCUSSION

Two kinds of issue have emerged in connection with CESG Contention 18/Palmetto Alliance 44; legal and technical. In the main CESG does not challenge the proposed licensing action on the basis of non-compliance with regulations, though it notes the many exemptions given the Applicant in regard to meeting Appendices G and H, 5

foregoing. Applicant usually accedes to Staff requirements. It is the way to gain Staff sanction and support in the licensing process. However when a situation has been misjudged, or erroneously anticipated as in the case of Oconee RT_{NDT} increase with neutron fluence, resulting in an Applicant being in noncompliance, the Staff revises the regulation, Appendices G and H have just been amended, 48 Fed. Reg. 24008 (May 27, 1983) and amends the license, Oconee amendments 119, 119 and 116 for units 1, 2 and 3 respectively, MS attachment. CESG, whose members live within 20 miles of the sites of four large reactors, is concerned with the world of experience, as opposed to that of regulatory legalisms, and is, accordingly focussing on technical matters and the substance and significance of the regulations.

CESG's position is this: that in the matter of reactor embrittlement the Staff did not at the time of early licensings, the Oconee generation, know enough to provide adequate regulation. This deficiency in knowledge is at a cost to the utility and to the rate payers. Subsequently it may be at a health and safety cost. And we think our material facts show that the Staff still does not know enough, nor sufficiently embody in the regulations such knowledge as will subsequently protect the utility and the public. Our deposition of Applicant's witness on reactor embrittlement brought forth a disclaimer of any fundamental knowledge. In response to our technical interrogatories the answers were provided by the vendor, not the utility.

Staff can be reasonably perceived as having believed at the time of licensing Oconee that the provisions of Section II C 3 a were realistic and would be met. Experience has shown that a projection of an end-of-life RT_{NDT} less than $100^{o}F$ was wrong.

This unrealistic projection was also made for Robinson-2, San Onofre-1, Maine Yankee, Palisades and Yankee-Rowe. Staff has avoided shutting down these reactors, or requiring them to be annealed, by devising operating limit curves. MS attachment Fig. 3.1.2-1A, 1B, and 1C; 2A, 2B, and 2C; and 3A, 3B, and 3C. Further, by use of the limit curve procedure, Staff contemplates permitting the operation of reactors in which the projected RT_{NDT} at beltline is 270°F for axial welds and 300°F for circumferential welds. This is a bit like buying a new car and being told somewhat later by the manufacturer that you shouldn't drive over forty, or, to mention a specific case, brake hard. Clearly the Staff proceeded in the past on the basis of inadequate information. In our view it is still proceeding with inadequate information. It is our hope that it will not take a reactor breach to establish this point.

1. The test coupons do not provide information in regard to the weakest point in the reactor. If the reactor breaches the failure will start at this point. It represents the far end of the distributions of properties and stresses. It is the critical value. The part that doesn't fail doesn't matter.

2. The RT_{NDT} information bears only indirectly a) on the characteristics of the weakest spot in the reactor and b) the conditions to which it may be exposed.

3. The most adverse condition to which a reactor is likely to be exposed is a pressurized condition during a LOCA in which ECCS water at a temperature no higher than 70°F is injected. Under these conditions the operator is not controlling. The limit curve will be violated.

4. The stresses and stress gradients during both pressurized and unpressurized heatup and cooldown fatigue the materials of the reactor. The capacity to withstand stress is reduced by fatigue.

An aged reactor which has both embrittled and fatigued is particularly vulnerable to the stresses of LOCA events in which the reactor coolant pressure remains high.

5. Test coupons are not fatigued. They provide no indication of the actual condition of the most vulnerable material in the reactor.

6. The interface between reactor plate and weld metal is not included in the coupon test program nor specified in the regulation.

7. Although coupons are said to experience about a factor 4 less neutron flux than the inner surface of the reactor there is no demonstration that this is sufficient to compensate for the deficiencies mentioned foregoing.

8. The imprecission and lack of accuracy of RT_{NDT} projections is demonstrated by a comparison of Reg. Guide 1.99 and Guthrie formula values.

Lifetime RT_{NDT}*

Method	Catawba-1	Catawba-2	Ref.
Reg. G. 1.99	108°F	109°F	MS, mat. fact 7
Guthrie	112°F	76.5°F	MS, mat. fact 8
95% confidence	162°F	124.5°F	MS, mat. fact 19

*cf. MS Table 1

9. The NRC has not claimed that brittle fracture would be eliminated by 10 CFR 50 Appendices G and H, only that "the probability of rapidly propagating fracture is minimized." MA III A, p. 7. Uncertainties are identified in "determining (a) material properties, (b) the effects of irradiation, (c) residual, steady state and transient stress, and (d) size of flaws", ibid. These uncertainties have neither been quantified nor resolved. The Commission admissions correspond to many but not all of Intervenor's concerns.

10. The regulations transfer focus and emphasis to test results on coupons and away from the reactor vessel, where it properly should be. MA p.12.

CONCLUSION

None of the material facts adduced by Applicant and Staff, with which Intervenor concurs, twelve of Applicant's fourteen, eleven of Staff's twenty, bear directly on the actual capacity of the Catawba reactors to withstand stresses under faulted conditions, including the effects of embrittlement and fatigue. The remaining material facts alleged by Applicant and Staff have been controverted. Intervenor has presented twenty-three material facts which support the conclusion that there is not an adequate technical basis for assuring the reactor will not be breached by stresses which it may oncounter during its operating lifetime. This Board, accordingly, should dismiss Applicant's and Staff's motions for summary disposition of CESG Contentention 18/Palmetto Alliance 44.

Respectfully submitted,

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In the Matter of DUKE POWER COMPANY, ET AL. (Catawba Nuclear Station, Units 1 and 2)	Docket Nos. 50-413 50-414

AFFIRMATION OF SERVICE

I hereby affirm that copies of "CESG'S OPPOSITION TO APPLICANT AND STAFF MOTIONS FOR SUMMARY DISPOSITION OF CESG CONTENTION 18/PALMETTO 44" in the above captioned proceeding have been served on the following by deposit in the United States mail, first class, or as indicated by an asterisk, by U.S. overnight mail this 15th day of August, 1983:

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