RAS 8427

August 31, 2004

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of

DUKE ENERGY CORPORATION

(Catawba Nuclear Station, Units 1 and 2)

Docket No's. 50-413-OLA,
50-414-OLA

BLUE RIDGE ENVIRONMENTAL DEFENSE LEAGUE'S PROPOSED REPLY FINDINGS OF FACT AND CONCLUSIONS OF LAW REGARDING BREDL CONTENTION I

Blue Ridge Environmental Defense League ("BREDL") hereby submits its proposed reply findings of fact and conclusions of law regarding BREDL Contention I.

Introduction

1. Duke Energy Corporation ("Duke") and the U.S. Nuclear Regulatory Commission ("NRC") or ("Commission") have submitted proposed findings of fact and conclusions of law that would have us find that Duke's license amendment request ("LAR") to test plutonium mixed oxide ("MOX") fuel at the Catawba nuclear power plant is adequate with respect to its consideration of the differences between MOX and low enriched uranium ("LEU") fuel behavior and the impact of these differences on Duke's analysis of loss of coolant accidents ("LOCAs"). Duke Energy Corporation's Proposed Findings of Fact and Conclusions of Law Regarding Contention I (August 6, 2004) (hereinafter "Duke Proposed Findings"); NRC Staff's Proposed Findings of Fact and Conclusions of Law Concerning BREDL Contention I (August 6, 2004) (hereinafter "NRC Staff Proposed Findings").

Template=SECY-057

SECY-02

2. We see little in Duke's and the NRC Staff's Proposed Findings that has not already been addressed by BREDL's thorough and well-considered findings. *See* Blue Ridge Environmental Defense League's Proposed Findings of Fact and Conclusions of Law Regarding Contention I. We do note, however, that Duke goes to some lengths to disparage the credibility of Dr. Lyman, by directly attacking his qualifications and by attempting to characterize his testimony as erroneous in significant respects. The Staff also questions Dr. Lyman's qualifications to some degree. As discussed below, we find these attacks on Dr. Lyman's qualifications to be unjustified, and we accord his expert testimony full weight.

3. As a preliminary matter, we observe that while Dr. Lyman made some mistakes in interpreting data that was presented in this proceeding, he was not alone. Duke and the NRC Staff also made a number of errors, as revealed in their testimony. *See* NRC Staff Proposed Findings, n.5; par. 7 below. If the commission of errors were the sole criterion for evaluating a witness's qualifications, then few of the witnesses who appeared before us would be qualified. We think that the lack of experimental work on the behavior of plutonium fuel has been a contributing factor to the lack of clear understanding of MOX fuel behavior that is evident in this proceeding. We also think the hearing had a salutary effect of refining and clarifying some of the evidence that was subject to mistaken interpretation.

4. Duke and the NRC Staff urge us to find that Dr. Lyman's qualifications to testify regarding Contention I are limited because he does not have direct experience in LOCA analyses and because his experience is largely policy-oriented. Duke Proposed Findings, par. 16; NRC Staff Proposed Findings, Par. 4.7. We do not think the fact that Dr. Lyman has not done LOCA analyses detracts in any way from his ability to evaluate the LOCA analyses that have been presented here. Dr. Lyman has considerable experience with analysis of technical nuclear safety

issues, as reflected by the detail and sophistication of his testimony in this proceeding. We find that he is capable of understanding complex technical issues because of his extensive in training in physical sciences. Moreover, although Dr. Lyman's career does show a strong interest in government policy that affects nuclear safety, we do not believe that he has focused his work on policy to the exclusion of technical analysis.

5. At several points in their proposed findings, Duke and the Staff attack Dr. Lyman's credibility by pointing to alleged errors in his testimony. For instance, in par. 117, Duke criticizes Dr. Lyman for citing, in BREDL's original contention regarding impacts of using MOX fuel on Duke's LOCA analysis, VERCORS severe accident test data. This error, which BREDL corrected during a prehearing conference soon after the contention was filed, was due to the fact that IRSN used the word "relocation" in both the context of LOCA analysis and severe accident analysis. Thus, the error appears to stem from IRSN's awkward translation of nuclear accident concepts from French into English, rather than any inadequacy in Dr. Lyman's qualifications.

6. In par. 118, Duke asserts that Dr. Lyman did not realize that the relocation effect was at the ruptured location, which is not the site of the peak cladding temperature ("PCT") in a LOCA analysis. This was not an error. Dr. Lyman was following the IPSN's simplified methodology, which characterized the increase of 313 degrees Fahrenheit as an increase in PCT, and did not take into account the cooling effects at the ballooned location.

7. In par. 119, Duke argues that in his rebuttal testimony, Dr. Lyman "erroneously drew correlations from Exhibits 15 and 16, without recognizing that the test conditions in the two exhibits were not directly comparable." Duke also asserts that Dr. Lyman "extracted an invalid 20^0F penalty from Exhibit 16." *Id.* In making this argument, however, Duke overlooks the fact that it failed to provide a complete specification of the initial conditions for the two tests when it

submitted Exhibits 15 and 16. These specifications were not provided until the day of the hearing, by the NRC Staff. *See* Exhibit 46 (Excerpt from E.H. Karb et al paper (October 1980). Thus, Dr. Lyman reasonably drew an inference that other than initial burnup, the conditions of the tests were the same. We also note that it is not possible to verify, based on the documents submitted as evidence in this proceeding, that the graph in Exhibit 15 corresponds to the test results that it purports to represent. The values for burst temperature and maximum cladding temperature for Test B3.1 for FR2 in-pile test results that are presented in Table 4 of Exhibit 46 do not appear to correspond to the graph in Exhibit 15, which Duke labels as FR2 Test B3.1. In fact, if one looks at the data in Exhibit 46 and compares tests B3.1 and E4, one finds that the listed PCT is actually smaller for Test E4, which has a greater initial heatup rate than Test B3.1. This data contradicts the implication in Mr. Dunn's testimony that the power "directly controls the temperature you reach in those tests." Tr. at 2338. The discrepancy between Exhibit 15 and Exhibit 46 raises the question whether Duke and the Staff have interpreted the test data correctly. It also reaffirms our belief that Dr. Lyman made the best of some very sparse and poorly presented data.

8. In par. 120, Duke asserts that Dr. Lyman attempted to draw conclusions regarding fuel fragmentation during a design basis LOCA by referencing Exhibit 51, the CABRI tests. According to Duke, these tests involved fuel behavior under design basis reactivity initiated accident conditions and "are not representative of LOCA fuel behavior." Dr. Lyman's testimony demonstrates, however, that he clearly understood the CABRI tests to be related to reactivity and not LOCA fuel behavior. Tr. at 2467-68. As he stated:

> The CABRI tests, of course, [are] reactivity insertion accidents which are associated with much more rapid rising of temperature than loss of coolant accident[s], but the information that's come out from those tests about high burnup fuel structure, I think, is relevant to our understanding of what occurs [in] the LOCA.

It should also be noted that Dr. Lyman found it necessary to cite the CABRI tests because of the complete absence of data regarding the behavior of MOX fuel under LOCA conditions.

9. In par. 121, Duke criticizes a mistake made by Dr. Lyman in his testimony, in which he cited observations of fuel relocation in LEU fuel with rod burnups exceeding "around 48 GWD/t." At the hearing, Dr. Lyman conceded that the figure should have been 48 MWD/t. Most importantly, as Dr. Lyman pointed out during cross-examination, this correction strengthens his argument that it is the high burnup phenomena, rather than low burnup phenomena, that lead to the differences in fragmentation behavior between MOX and LEU fuel that constitute a key concern raised by Contention I. Tr. at 2465-66.

10. In par. 122, Duke makes a vague and completely unsupported assertion that Dr. Lyman's concern regarding the uncertainty in Duke's LOCA analysis regarding MOX fuel is a mere "theory," in which uncertainty is a "moving target" that has changed based on Dr. Lyman's review of "literature that often is not applicable." The origin of the uncertainty regarding MOX fuel behavior under LOCA conditions has not changed at all since BREDL filed its contention. Clearly, the cause of the uncertainty is the complete absence of experimental data on the subject. Moreover, Duke has failed to show that the literature cited by Dr. Lyman is inapplicable. To the contrary, we find that it supports his testimony. Given the valid concerns raised by Dr. Lyman, we think it is a major safety problem that no experimental data whatsoever is available regarding the behavior of plutonium MOX fuel under LOCA conditions.

11. Duke asserts that MOX fuel has been previously approved by the NRC for use in U.S. commercial reactors, and that there is a "substantial experience base" because it is used in European reactors. Duke Proposed Findings, par. 20. This argument misses the point of Contention I, however, which is that there has been no testing of MOX fuel behavior under

LOCA conditions. Data regarding the behavior of MOX fuel under normal conditions provides limited insight into how it will behave in a LOCA.

12. In par. 70, Duke cites Dr. Ralph Meyer's testimony for the proposition that filling ratios for MOX fuel are likely to be 0.5 to 0.6, and are unlikely to meet or exceed the 0.7 assumed in the limiting IRSN calculations. Duke incorrectly paraphrases Dr. Meyer's testimony. In fact, Dr. Meyer said that: "it's hard to imagine densities much above 70%, which are already included in the studies." Tr. at 2643. Thus, contrary to Duke's Proposed Findings, Dr. Meyer does not state that filling ratios are unlikely to reach 0.7. This mischaracterization is significant because the higher the filling ratio, the more severe the relocation effect will be.[1]

13. In par. 4.33, the NRC Staff asserts that BREDL did not offer any evidence to show that one could increase the packing fraction above what is already assumed in the parametric study done by IRSN. The Staff distorts Dr. Lyman's testimony. Dr. Lyman has not argued that packing fractions necessarily would be much greater than the maximum assumed by IRSN, but only that the differences in microstructure between MOX and LEU fuel would lead to a consistently greater packing fraction for MOX than for LEU. Therefore, the relocation effects may be more severe for MOX fuel than for LEU fuel. Tr. at 2559-61.

14. In par. 66, Duke states that Dr. McCoy testified that "rim" regions are tougher and more resistant to cracking. But Duke has not addressed Exhibit 52 (LOCA Results for Advanced-Alloy and High-Burnup Zircaloy Cladding), which consists of the results of an Argonne integral LOCA test of high burnup fuel. That test showed that circumferential tearing occurs in regions of high

[1] Contrary to Duke's inference, Dr. Meyer's testimony at page 2639 does not state that he believes the maximum filling ratio is likely to be 0.6. In fact, we don't see any clear statement by Dr. Meyer at page 2639 regarding the filling ratio. His testimony seems to be concerned with the size of the balloon rather than the filling ratio.

fission gas concentration (*i.e.*, the rim region). *See* Tr. at 2474-77, 2526-27. At page 5, Exhibit 52 states that:

> During ballooning, the cladding pulls away from the fuel. This allows space for fuel particles (macro-cracked, micro-cracked, and very small particles from the rim layer) to fall into the balloon region.

This evidence contradicts Duke's assertion that rim material will not yield fine particles.

15. In par. 112, Duke simply adds the increase in local oxidation obtained from the IRSN study to the oxidation that Duke calculated in its MOX LTA LOCA analysis in order to estimate the maximum impact of fuel relocation on local oxidation. As Dr. Lyman testified, Duke's approach is overly simplistic. Tr. at 2516-17.

Conclusion

16. We have reviewed Duke's and the NRC Staff's Proposed Findings, and find that they do not effectively controvert the proposed findings submitted by BREDL. BREDL has done a thorough job of addressing the evidence and explaining why Duke's evidence and legal arguments are insufficient to carry its burden of proving that Duke complies with NRC regulations for the safe operation of the Catawba nuclear power plant using plutonium MOX LTAs. *See* 10 C.F.R. 2.732.

17. We find Duke's general characterization of Dr. Lyman's testimony as speculative to be unsupported. Dr. Lyman has distilled and presented for our consideration significant support for BREDL's contention that MOX fuel may have a more severe response to relocation effects than LEU during a LOCA, and that further experimental evidence is needed to quantify and bound those effects. Duke has been unable to marshal a single bit of experimental support for its claim that there will be no significant difference in fragmentation behavior and relocation effects between LEU fuel and MOX fuel during a LOCA. Therefore, we conclude that Duke has failed

to give adequate consideration to the effect of MOX fuel relocation on Duke's ability to demonstrate that the LAR is in compliance with the emergency core cooling system (ECCS) acceptance criteria in 10 C.F.R. § 50.46.

Respectfully submitted,

Diane Curran
Harmon, Curran, Spielberg, & Eisenberg, L.L.P.
1726 M Street N.W., Suite 600
Washington, D.C. 20036
202/328-3500
e-mail: Dcurran@harmoncurran.com

August 31, 2004

CERTIFICATE OF SERVICE

I hereby certify that on August 31, 2004, copies of Blue Ridge Environmental Defense League's Reply Findings of Fact and Conclusions of Law Regarding BREDL Contention I were served on the following by e-mail and/or first-class mail, as indicated below.

Ann Marshall Young, Chair
Administrative Judge
Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Mail Stop: T-3F23
Washington, D.C. 20555
E-mail: AMY@nrc.gov

Anthony J. Baratta
Administrative Judge
Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Mail Stop: T-3F23
Washington, D.C. 20555
E-mail: AJB5@nrc.gov

Office of Commission Appellate Adjudication
U.S. Nuclear Regulatory Commission
Mail Stop: O-16C1
Washington, D.C. 20555

Thomas S. Elleman
Administrative Judge
Atomic Safety and Licensing Board
4760 East Country Villa Drive
Tucson, AZ 85718
E-mail: elleman@eos.ncsu.edu

Susan L. Uttal, Esq.
Antonio Fernandez, Esq.
Margaret J. Bupp, Esq.
Office of the General Counsel
Mail Stop - O-15 D21
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001
E-mail: slu@nrc.gov axf2@nrc.gov, mjb5@nrc.gov

Mary Olson
Southeast Office, Nuclear Information and Resource Service
P.O Box 7586
Asheville, NC 28802
E-mail: nirs.se@mindspring.com

Lisa F. Vaughn, Esq.
Timika Shafeek-Horton, Esq.
Legal Dept. (PBO5E)
Duke Energy Corporation
526 South Church Street (EC11X)
Charlotte, NC 28201-1006
E-mail: lfVaughn@duke-energy.com

Janet Marsh Zeller, Executive Director
Blue Ridge Environmental Defense League
P.O. Box 88
Glendale Springs, NC 28629
E-mail: BREDL@skybest.com

David A. Repka, Esq. Anne W. Cottingham, Esq. Mark J. Wetterhahn, Esq. Winston & Strawn, LLP 1400 L Street, N.W. Washington, D.C. 20005-3502 E-mail: drepka@winston.com acotting@winston.com mwetterhahn@winston.com Office of the Secretary (original and two copies) ATTN: Docketing and Service U.S. Nuclear Regulatory Commission Mail Stop: O-16C1 Washington, D.C. 20555 E-mail: HEARINGDOCKET@nrc.gov	

Diane Curran