WINSTON & STRAWN LLP

1400 L STREET, N.W., WASHINGTON DC 20005-3502
202-371-5700

35 W. WACKER DRIVE, CHICAGO IL 60601-9703, 312-558-5600
200 PARK AVENUE, NEW YORK, NY 10166-4193, 212-294-6700
38TH FLOOR, 333 SOUTH GRAND AVE, LOS ANGELES, CA 90071-1543, 213-615-1700
101 CALIFORNIA STREET, SAN FRANCISCO CA 94111-5894, 415-591-1000
43 RUE DU RHONE, 1204 GENEVA, SWITZERLAND, 41-22-317-75-75
21 AVENUE VICTOR HUGO, 75116 PARIS, FRANCE, 33-1-53-64-82-82
CITY POINT, 1 ROPEMAKER STREET, LONDON, ENGLAND EC2Y 9HT, 44-207-153-1025

July 8, 2004

Ann Marshall Young, Chairman
Administrative Judge
Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Anthony J. Baratta
Administrative Judge
Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dr. Thomas S. Elleman
Administrative Judge
5207 Creedmoor Road # 101
Raleigh, N.C. 27612

Re: Duke Energy Corporation, Catawba Nuclear Station, Units 1 and 2 (Docket Nos. 50-413-OLA, 50-414-OLA)

Dear Administrative Judges:

Enclosed for filing in the above-referenced docket is the rebuttal testimony of Duke Energy Corporation on Contention 1.

Very truly yours,

David A. Repka

David A. Repka
Counsel for Duke Energy Corporation

Enclosure

cc : See enclosed Certificate of Service

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	
DUKE ENERGY CORPORATION	)	Docket Nos. 50-413-OLA 50-414-OLA
	)	
(Catawba Nuclear Station, Units 1 and 2)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of "REBUTTAL TESTIMONY OF STEVEN P. NESBIT, ROBERT C. HARVEY, BERT M. DUNN, AND J. KEVIN McCOY ON BEHALF OF DUKE ENERGY CORPORATION ON CONTENTION I" in the captioned proceeding have been served on the following by Federal Express overnight courier this 8th day of July, 2004. Additional e-mail service has been made this same day, as shown below.

Ann Marshall Young, Chairman
Administrative Judge
Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
(e-mail: AMY@nrc.gov)

Anthony J. Baratta
Administrative Judge
Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
(e-mail: AJB5@nrc.gov)

Dr. Thomas S. Elleman
Administrative Judge
5207 Creedmoor Road, #101
Raleigh, NC 27612
(e-mail: elleman@eos.ncsu.edu)

Office of the Secretary
U.S. Nuclear Regulatory Commission
Washington, DC 20555
Attn: Rulemakings and Adjudications Staff
(original + one copy)
(e-mail: HEARINGDOCKET@nrc.gov)

Susan L. Uttal, Esq.
Antonio Fernandez, Esq.
Margaret J. Bupp, Esq.
Office of the General Counsel, O-15D21
U.S. Nuclear Regulatory Commission
Washington, DC 20555
(e-mail: slu@nrc.gov)
(e-mail: axf2@nrc.gov)
(e-mail: mjb5@nrc.gov)

Diane Curran
Harmon, Curran, Spielberg & Eisenberg, LLP
1726 M Street, N.W.
Suite 600
Washington, DC 20036
(e-mail: dcurran@harmoncurran.com)

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

Adjudicatory File
Atomic Safety and Licensing Board Panel
U.S. Nuclear Regulatory Commission
Washington, DC 20555

David A. Repka
Counsel for Duke Energy Corporation

July 8, 2004

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	
DUKE ENERGY CORPORATION	)	
	)	Docket Nos. 50-413-OLA
(Catawba Nuclear Station,	)	50-414-OLA
Units 1 and 2)	)	
	)	
	)	

REBUTTAL TESTIMONY OF
STEVEN P. NESBIT, ROBERT C. HARVEY, BERT M. DUNN, AND J. KEVIN McCOY
ON BEHALF OF DUKE ENERGY CORPORATION ON CONTENTION I

Template=SECY-055

SECY-02

TABLE OF CONTENTS

July 8, 2004

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	
DUKE ENERGY CORPORATION	)	
	)	Docket Nos. 50-413-OLA
(Catawba Nuclear Station,	)	50-414-OLA
Units 1 and 2)	)	
	)	
	)	

REBUTTAL TESTIMONY OF STEVEN P. NESBIT, ROBERT C. HARVEY, BERT M. DUNN, AND J. KEVIN McCOY ON BEHALF OF DUKE ENERGY CORPORATION ON CONTENTION I

I. INTRODUCTION

1. *(Nesbit)* I, Steven P. Nesbit, am an Engineering Supervisor II employed by Duke Energy Corporation (Duke). I currently serve as the Duke Mixed Oxide (MOX) Fuel Project Manager. A full statement of my Professional Qualifications was included with Duke's initial written testimony in this proceeding.

2. *(Harvey)* I, Robert C. Harvey, am a Senior Engineer employed by Duke, responsible for the Loss of Coolant Accident (LOCA) analyses supporting the Oconee Nuclear Station (Oconee), McGuire Nuclear Station (McGuire), and Catawba Nuclear Station (Catawba). A full statement of my Professional Qualifications was included with Duke's initial written testimony in this proceeding.

3. *(Dunn)* I, Bert Dunn, am an Advisory Engineer employed by AREVA Framatome ANP, Inc. A full statement of my Professional Qualifications was included with Duke's initial written testimony in this proceeding.

4. *(McCoy)* I, J. Kevin McCoy, am an Advisory Engineer in the fields of metallurgy and materials engineering, employed by AREVA Framatome ANP, Inc. A full statement of my Professional Qualifications was provided with Duke's initial written testimony in this proceeding.

5. *(All)* Based on our specific job responsibilities, we are all very familiar with Duke's License Amendment Request (LAR), dated February 27, 2003. The LAR seeks NRC approval for Duke's proposal to use four MOX fuel lead assemblies at Catawba. The MOX fuel lead assemblies will be included in cores that will be predominantly comprised of Low Enriched Uranium (LEU) fuel assemblies.

6. *(All)* The purpose of this rebuttal testimony is to specifically address the written testimony of Dr. Edwin S. Lyman regarding Contention I in this proceeding. Dr. Lyman's testimony was submitted on behalf of the Blue Ridge Environmental Defense League (BREDL) on July 1, 2004. We show how the issues raised by Dr. Lyman were previously addressed in our initial direct testimony in this proceeding, also filed on July 1, 2004. We also provide some additional responses to those issues. In general, as we concluded previously, the issues (or "uncertainties") raised by Dr. Lyman are well-bounded by the conservatisms in the NRC's requirements and in Duke's analyses of a postulated Loss of Coolant Accident (LOCA).

II. GENERAL OBSERVATIONS (A.4 - A.6)

7. *(Nesbit)* Dr. Lyman summarizes the BREDL case by stating in his Answer to Question 4 (A.4)[1] that: "In my professional judgment, Duke's design-basis loss of coolant ('DB-LOCA') analysis is inadequate because it does not address the uncertainties associated with relocation effects that M5-clad MOX fuel may experience under LOCA conditions." He goes on

[1] References to specific Answers in the BREDL or NRC Staff testimony are referenced herein as "A.x," where x is the Question/Answer number.

in A.4 to state that: "Duke has failed to address these uncertainties in MOX fuel behavior, and therefore its [lead test assembly] application is unacceptable to satisfy the requirements of 10 C.F.R. § 50.46 with respect to [peak cladding temperature (PCT)], maximum cladding oxidation, and coolable geometry of fuel. In addition, by failing to address the uncertainties in MOX fuel behavior, Duke has not demonstrated compliance with the general reasonable assurance standard in 10 C.F.R. § 50.40(a)."

8. *(Nesbit)* First, Dr. Lyman provides no expert opinions, data, or analyses to support his professional judgment. Dr. Lyman claims to be a "qualified expert on nuclear safety and safeguards issues." However, he has no experience performing LOCA analyses or conducting experiments related to LOCA phenomena. He has written and spoken extensively on nuclear issues, but his work is predominantly in the policy arena. Dr. Lyman's judgments are based entirely on statements made by other people. BREDL offers none of those people as expert witnesses so they can be questioned by Duke. None of the sources referenced by Dr. Lyman specifically address the safety of the Duke MOX fuel lead assembly license amendment request. The sources of most of the BREDL "uncertainties" are proposals for experiments by a French research agency, the Institute for Radiological Protection and Nuclear Safety (IRSN). IRSN's desire to conduct experiments related to MOX fuel must be viewed in context — French nuclear safety regulators have taken no action to curtail MOX fuel use in the twenty French reactors that use substantial quantities of MOX fuel.

9. *(Nesbit)* Dr. Lyman has made no definitive statement that the MOX fuel lead assemblies would be unsafe — he claims in A.4 only that ". . . the impact of fuel relocation effects during a LOCA *may* be more severe for MOX fuel rods than for LEU fuel rods" (emphasis added). However, the presence of "uncertainty" is not surprising and certainly does

not alone preclude approval for a lead assembly program. There is no such thing as perfect certainty, particularly for a lead assembly program that has, as its fundamental purpose, the goal of acquiring more data.

10. *(Nesbit)* Moreover, a proposal for research by a foreign organization cannot be equated with the existence of *unacceptable* uncertainty. Would BREDL apply this same requirement across the board — must every nuance of every possible difference associated with every change to every nuclear plant structure, system, or component be exhaustively tested at accident conditions prior to implementing that change? We addressed the uncertainty issue in detail in Section VI (paragraphs 158-171) of our initial testimony. We continue to take issue with Dr. Lyman's judgment in this regard.

11. *(Nesbit)* Most significantly, uncertainty is routinely addressed by conservatism (or "margin") in regulatory requirements and licensing analyses. Dr. Lyman does not acknowledge the inherent margin in Appendix K LOCA calculations. In fact, there is substantial conservatism in Appendix K design basis LOCA calculations, as we discussed in detail in Section III.D (paragraphs 60-65) of our initial testimony. *These conservatisms add up to approximately 600°F PCT margin relative to best estimate calculations.*

12. *(Nesbit)* Dr. Lyman also does not acknowledge beneficial characteristics of the MOX fuel lead assemblies with respect to Appendix K LOCA calculations. Section III.C (paragraphs 43-55) of our initial testimony summarized the conservative modeling techniques employed by AREVA in the MOX fuel Appendix K evaluation model. These include using LEU models for decay heat and neutron power, rather than taking credit for beneficial MOX fuel characteristics for those parameters (*see* paragraphs 63-65 of our initial testimony). Dr. Lyman claims in A.4 that "calculations in Duke's LAR indicate that MOX fuel is generally more

limiting than LEU fuel with respect to DB-LOCAs." In fact, however, as discussed in paragraph 58 of our previous testimony, we showed that an "apples to apples" comparison of MOX and LEU fuel shows essentially no difference (less than 40°F in PCT) between the fuel types, without taking any credit for the beneficial aspects of MOX fuel.

13. *(Harvey)* In his response to Question 6 (A.6) Dr. Lyman alleges the "non-conservatism" in Appendix K based on the "omission of fuel relocation effects" as supposedly reflected in various regulatory documents and NRC Generic Issue (GI) 92. We addressed this in our initial testimony at paragraphs 94-96 and 144. Dr. Lyman goes on to state". . . the NRC has acknowledged that omission of fuel relocation effects is a non-conservatism in Appendix K with a very large potential impact on PCT . . . ." To our knowledge, however, the NRC has never made such a statement — it is certainly not present in BREDL Exhibits B and C referenced by Dr. Lyman in A.4. Those NRC documents only state that fuel relocation remains an issue of interest in Europe, and that fuel relocation during a LOCA is one potential non-conservatism in present Appendix K methods (evaluation models). BREDL Exhibit C, Attachment 4 at 5 (the "Thadani memorandum"), suggests an impact on PCT of at least +46°F but does not endorse the higher PCT values calculated by Grandjean, et al. (BREDL Exhibit E; Duke Exhibit 4).

14. *(Harvey)* As we stated in Section III.D of our initial testimony (paragraphs 60-62), in addition to any non-conservatism related to fuel relocation, there are many clearly identified conservatisms in the Appendix K methods. In fact, the Thadani memorandum (BREDL Exhibit C), identifies one proposed regulatory option which would allow licensees to continue to use the presently-accepted Appendix K methods as grandfathered and therefore no reanalysis would be required. In the other proposed option, a licensee could choose to use a revised Appendix K rule that would relax some of the known conservative requirements. The

licensee would then need to account for the potential non-conservatisms in the approved evaluation model. Clearly, the current Appendix K approach relies on the known conservatisms to more than offset any of the potential non-conservatisms. If a licensee would choose to apply the revised Appendix K requirements, better understanding of the non-conservatisms (including any fuel relocation effect) would be required in order to accurately represent those effects. This is not the case in the LAR, which is based on presently-accepted Appendix K methods and includes all of the inherent Appendix K conservatisms.

15. *(Nesbit)* In the second paragraph of A.6, Dr. Lyman makes other conclusory comments on the relocation issue. He suggests that "certain characteristics of MOX fuel appear to exacerbate the effects of fuel relocation, thus leading to higher PCTs and greater maximum cladding oxidation." However, he offers no quantitative assessment to dispute our quantitative analysis or to show how a MOX relocation effect could challenge the margin relative to a best estimate calculation. Furthermore, we have addressed in Sections IV and V of our initial testimony each and every one of the suggested, qualitative "differences" between MOX and LEU fuel and concluded that they do not involve significant negative impacts. We address these again in this rebuttal testimony, to the extent warranted.

16. *(Nesbit)* Finally, BREDL Contention I is also fundamentally a challenge to the application of Appendix K LOCA models to all nuclear fuel, including LEU fuel. Relocation can occur in LEU fuel during design basis LOCA conditions, and no Appendix K LOCA models address fuel relocation. Even if BREDL's supposition that relocation may be worse in MOX fuel were true, it is our professional judgment that the difference would only be a matter of a relatively small degree. At bottom, we do not believe that fuel relocation needs to be specifically modeled in LOCA analyses for either MOX or LEU fuels.

III. LOCAL LINEAR HEAT GENERATION RATE (A. 8, A.10)

17. *(Dunn)* Dr. Lyman starts from the premise, in his A.8, that postulated fuel relocation increases the local linear heat generation rate within the ballooned area and therefore could increase the severity of a LOCA by increasing PCT and maximum cladding oxidation relative to an analysis that does not model relocation. He specifically states that: ". . . the greater local linear heat generation rate requires a greater coolant flow around the ballooned area to ensure long-term core coolability."

18. *(Dunn)* With respect to the first part of this testimony in A.8, in Section V.G of our initial testimony (paragraphs 145-157) we have already shown that the impact of fuel relocation on calculated PCT and local cladding oxidation is not significant, even with very conservative assumptions.

19. *(Dunn)* With respect to the second part of the testimony in A.8, the fact is that there is no significant impact on "long-term coolability" around a ballooned area. Long-term cooling is established following initiation of core quench through the use of extended service pumped injection. For the most severe LOCA scenarios (breaks in the Reactor Coolant System cold legs), the core transitions to a boiling pot mode following reflood and core quench. The core inlet flow does not change due to fuel relocation — core flow is based on total core power (decay heat), not on the distribution of that power. Within the core region cooling is by pool boiling, a heat transfer mechanism that is dependent on coolant availability, but not on flow rate. The pool boiling mechanism is very efficient and is stable for heat fluxes more than an order of magnitude higher than those required by the long term core power. Coolant availability can be supplied from below, laterally across assemblies, or from down flow without difficulty. Cooling is ample at greatly reduced flow areas, even assuming a larger local heat source. Thus, there will be no

degradation in the long term cooling process for either LEU or MOX fuel, even if the local power generation were to increase due to fuel relocation.

20. *(Dunn)* Accordingly, both aspects implied by Dr. Lyman in A.8 are incorrect: the increase in local linear heat generation rate within the ballooned area will not lead to significant increases in PCT in that area and long-term core coolability will be maintained.

21. *(Nesbit)* In A.10 Dr. Lyman states: "MOX fuel may experience more severe relocation effects than [LEU] fuel at the same burnup because several characteristics that are important for relocation may be less favorable for MOX fuel. These include pellet fragment size and fuel-clad interaction." Again, Dr. Lyman makes no definitive statement that MOX fuel would be worse in this regard. As we have shown in our testimony and will show further in this rebuttal, there is no data indicating that MOX fuel would perform worse. However, Dr. Lyman has ignored the clear evidence that the Catawba MOX fuel lead assemblies would be better than their co-resident LEU fuel assemblies in one key aspect — peak linear heat generation rate (*see* Section V.4, paragraphs 129-142 of our initial testimony).

IV. PELLET FRAGMENT SIZE (A.11)

22. *(McCoy)* In paragraph 2 of A.11, Dr. Lyman states that: "The fuel relocation phenomenon has been observed in LEU fuel for rod burnups exceeding around 48 GWD/t. *See* Grandjean, Hache and Rondier [sic] at 2 (2001) [BREDL Exhibit E; Duke Exhibit 4]. This suggests that vulnerability to fuel relocation is associated with the development of the high-burnup 'rim' region known to emerge in LEU fuel for burnups exceeding about 40-45 GWD/t."

23. *(McCoy)* Dr. Lyman's theory is that the MOX fuel pellets may experience greater fragmentation than LEU fuel pellets, and thus MOX fuel relocation will involve greater "fill fractions" with commensurately greater effects. We disagree with this theory.

24. *(McCoy)* Relocation during LOCA occurs when fuel pellet fragments are dislodged. Processes that might influence relocation include cracking of the pellets, accumulation of released fission gas, and bonding of the fuel to the cladding. In Section V.D of our initial testimony (paragraphs 117-121), we explained why no differentiation in pellet cracking and fragmentation should be made between MOX and LEU fuel. This was supported by the micrographs of irradiated fuel.

25. *(McCoy)* Dr. Lyman's argument appears to hinge on speculation that the susceptibility of fuel to relocation during LOCA is somehow related to the formation of a "rim" microstructure in the fuel. The "rim" microstructure develops in fuel that is irradiated at relatively low temperatures until a high local burnup is reached. It is characterized by a marked refinement of the grains and increased porosity. The "rim" microstructure is so named because in LEU fuels it appears first at the extreme periphery of the pellets. This is the region of an LEU fuel pellet where the local burnup is highest and the temperature is lowest.

26. *(McCoy)* Dr. Lyman suggests a relationship between relocation and microstructure of the fuel that is based only on the fact that susceptibility to fuel relocation and the formation of a "rim" structure occur at roughly comparable burnups. No mechanistic argument is given to relate relocation with the development of a "rim" structure.

27. *(McCoy)* Relocation requires that the fuel pellets lose their mechanical integrity. Therefore, if the "rim" microstructure is to affect relocation, it must do so by affecting the mechanical properties of the fuel. The mechanical properties of the "rim" regions are in fact different from those of the remainder of the fuel. Specifically, the "rim" regions are tougher, that is, more resistant to cracking. Therefore, the appearance of "rim" regions will not contribute to a loss of mechanical integrity or increase the susceptibility to relocation.

28. *(McCoy)* In paragraph 3 of Dr. Lyman's A.11, he states that: ". . . it is reasonable to expect that the onset of fuel relocation in MOX fuel may occur at lower rod-average burnups than in LEU fuel. This would imply that MOX fuel will be vulnerable earlier in its irradiation history (and consequently for a longer time) than LEU fuel." We do not agree with the logic of this testimony.

29. *(McCoy)* Dr. Lyman's discussion follows the same logic as his previous testimony: the "rim" microstructure appears earlier in MOX fuel than in LEU fuel, so if the "rim" microstructure embrittles the fuel, MOX fuel may be susceptible to relocation earlier than LEU fuel. But in fact the "rim" regions are tougher than the balance of the fuel, so the reasoning fails.

30. *(McCoy)* In paragraph 3 of A.11, Dr. Lyman next states that: ". . . the particle size distribution in MOX fuel will be smaller than in LEU fuel at the same rod-average burnup, to the extent that fine fragments are generated in the ultra-high burnup plutonium agglomerate regions." The apparent meaning of this statement is as follows: for fuel that forms large fragments of a certain size, plus fine particles of a smaller size, the mean particle size will decrease if the fraction of small particles increases.

31. *(McCoy)* We agree with Dr. Lyman's implied statement that the large fragments formed in MOX and LEU fuels with a given rod-average burnup will be of similar size. However, Dr. Lyman has not produced any evidence for his implied assertion that the plutonium-rich agglomerates in MOX fuel will produce a larger fraction of fine particles than will LEU fuel. The extra toughness imparted by the formation of the "rim" structure actually suggests that the agglomerates will not yield fine particles.

32. *(McCoy, Nesbit)* The issue of whether or not MOX fuel has a greater propensity to produce smaller fragments was discussed at the Advisory Committee on Reactor Safeguards (ACRS) meeting on MOX fuel (April 24, 2004). At that meeting, Dr. Lyman admitted that he has no evidence that MOX fuel has a smaller fragment size: "I would guess, to the extent that MOX starts fragmenting at lower burn-ups than LEU and a greater part of the fuel pellet is affected and fragmented, that may mean the mean particle size – or fragment size is lower for MOX. But I don't have any – I haven't seen anything." (Tr. at 27.) Dr. Dana Powers, the ACRS Subcommittee Chairman, responded: "What I am not aware of, and maybe you can help me there, is a tendency for MOX to fragment more extensively than LEU. In fact, one would think that MOX would have inherently a low fragmentation tendency, because crack tips get blunted." (Tr. at 17.) Later in the discussion, Dr. Lyman stated: "I don't know what it [the MOX/LEU difference in particle size distribution following fuel relocation] is, but it is certainly a difference that should be considered. It's possible that it is favorable [to MOX fuel]. (Tr. at 28.)

33. *(McCoy)* In paragraph 4 of Dr. Lyman's A.11, he next states that: "Because MOX fuel has a lower thermal conductivity and a higher radial temperature gradient than LEU fuel, it could experience greater fuel fragmentation during the blowdown and more severe relocation effects as a result." The point of the argument appears to be that MOX fuel has a lower thermal conductivity than LEU fuel, and therefore it is more susceptible to fragmentation by thermal shock.

34. *(McCoy)* Paragraph 68 of our initial direct testimony shows that the MOX/LEU difference cited by Dr. Lyman is not a significant effect. Figure 5 in that testimony shows that the difference between MOX and LEU thermal conductivity is small and that this difference does

not change significantly with burnup. The MOX pellet temperature profile should be very close to the LEU pellet temperature profile; accordingly, there will be no significant differences in thermal gradients or thermal stresses during blowdown. Therefore, the effect of these stresses on pellet fragmentation will be similar to that in LEU fuel.

35. *(McCoy, Dunn)* Finally, even if it could be shown that MOX fuel produces a larger fraction of fine particles than does LEU fuel, we expect that a substantial portion of such fine particles would not be retained in the cladding balloon and therefore would not be relevant to LOCA performance. In this regard, the testimony of Dr. Ralph Meyer on behalf of the NRC Staff (in his response to Question 40) indicates his view, based on recent high burnup integral tests, that the fine particles would not be retained: "It . . . appears that the small particles or fines are blown out of the burst opening when the rod depressurizes. Thus, there would be few or no small particles in the ballooned region, and it is these small particles that have been postulated to make a difference between the mass of fuel in the balloon in MOX fuel and LEU fuel."

36. *(Harvey)* In the third paragraph on page 6 in Dr. Lyman's A.11, he next refers to differences of opinion among "NRC experts" who participated in the 2001 PIRT panel on LOCAs and high burnup fuel. The PIRT panel actually looked at a number of aspects of high burnup fuel with respect to a LOCA event. The testimony of Dr. Lyman fails to point out that, under the category of "plant transient analysis," none of the PIRT panel rated fuel relocation as important; two rated it as "low medium" importance; and four rated it as low importance, stating that it has a small effect on the system analysis and it could make the burst (ruptured) node limiting. The last statement clearly reflects our point that the ruptured node is not necessarily the location of PCT. This latter point is demonstrated in the FR-2 tests without relocation illustrated by Figure 10 in our initial direct testimony. For the Catawba MOX fuel lead assemblies, the

PCT is *not* at the ruptured location, as shown by the Catawba MOX calculation (LAR Table 3-5)(Duke Exhibit 1).

37. *(Harvey)* Under the category of "transient fuel rod analysis," one expert rated fuel relocation as high importance, but qualified that by stating it was plant-dependent (that is, if the ruptured node was limiting it could make the event worse). Again, however, the ruptured node is *not* the highest PCT node for the Catawba MOX fuel LOCA analysis (as also described in paragraphs 36-40 and shown on Figure 1 of our initial testimony). The five other experts rated fuel relocation as having medium importance, stating only that it has a modest impact on the local heat rate.

38. *(Harvey)* In total context, there is little support from the PIRT expert panel that fuel relocation is an important phenomenon with respect to LOCA analyses, or more particularly with respect to the Catawba LOCA analyses. The fact that the ruptured node at Catawba is not the limiting PCT node renders speculation from various members of the PIRT panel largely academic.

V. FUEL-CLADDING INTERACTION (A.12)

39. *(McCoy, Dunn)* In paragraph 1 of A.12, Dr. Lyman, states that: "According to IPSN (now IRSN), tight fuel-clad bonding may delay the onset of fuel relocation. Mailliat and Schwarz at 433 [BREDL Exhibit G]. Tight bonding has also been observed at the Halden reactor in Norway to retard the rate of balloon formation."

40. *(McCoy, Dunn)* The question of fuel-cladding bonding is discussed at length in Section V.E of our initial direct testimony (paragraphs 122 through 128). Our conclusion is that "hypothetical MOX/LEU differences in this area do not affect the current regulatory position that relocation effects, if present at all, are adequately bounded by the inherently conservative nature

of Appendix K LOCA analyses" (paragraph 128). This conclusion remains valid. Nonetheless, we will make a few additional points.

41. *(McCoy, Dunn)* In paragraph 1 of Dr. Lyman's A.12, he states: "It has been confirmed that MOX fuel is more resistant to clad failures due to pellet-clad mechanical interaction (PCMI) than LEU fuel, even at high burnups. Nuclear Energy Agency, NEA/NSC/DOC(2004)8, *International Seminar on Pellet-Clad Interactions with Water Reactor Fuels*, at 20 (May 6, 2004) [BREDL Exhibit J]. . . . . This phenomenon is not well-understood but may imply that the pellet-clad bond is weaker for MOX fuel, in which case MOX fuel may have a greater propensity to earlier and more extensive fuel relocation than LEU."

42. *(McCoy, Dunn)* With regard to this testimony, it is worthwhile to refer directly to the document cited (BREDL Exhibit J). The relevant text reads as follows: "The reasons why MOX fuel and [chromium (Cr)-doped] fuel appear to behave better with respect to conventional [LEU fuel] under PCI conditions must be tackled further: is it fuel cracking propensity by itself, and/or is it enhanced viscosity reducing the hour-glass effect by dish filling and perhaps favouring peripheral cracking?" The original report makes no suggestion that pellet-cladding bonding is a possible explanation. Dr. Lyman's connection between PCMI performance and pellet-cladding bonding is speculation.

43. *(McCoy, Dunn)* Even if it were supposed that PCMI performance is influenced by pellet-cladding bonding, the strength of the bond is expected to be similar for MOX and LEU fuels. This was discussed in paragraph 123 of our direct testimony.

44. *(Nesbit)* In paragraph 2 of A.12, Dr. Lyman challenges Duke for failing to quantify the amount of conservatism in the MOX fuel LOCA analysis. He states that "... there is no way of knowing the degree to which this assumption (no fuel-cladding bonding) is

conservative for MOX fuel" and that this ". . . contributes another uncertainty to the safety margin associated with Duke's design basis LOCA calculation."

45. *(Nesbit)* In this specific instance, Duke's analysis takes no credit for fuel-cladding bonding to mitigate cladding swelling. This is a standard conservative assumption in Appendix K LOCA analyses of LEU fuel. There is no requirement that the impact of the "no fuel-cladding bonding" assumption be quantified for LEU fuel, and to our knowledge, no one has ever done so.

46. *(Nesbit)* Dr. Lyman specifically argues that Duke has failed to quantify ". . . the degree to which this assumption is conservative for MOX fuel." This argument reflects a lack of understanding of the governing requirements for LOCA emergency core cooling system analyses, 10 C.F.R. § 50.46 and 10 C.F.R. Part 50, Appendix K. Appendix K LOCA analyses provide a conservative estimation of PCT and cladding oxidation, as discussed in Section III.D (paragraphs 60-65) of our initial testimony. There is no requirement that licensees quantify the margin present in every individual aspect of an Appendix K LOCA analysis. In the overall context of Appendix K conservatisms, we do not see the need to quantify the value of one specific conservatism.

VI. CLADDING BALLOON SIZE (A.12 - A.14)

47. *(Harvey, Dunn)* In the last paragraph of his response to Question 12, and in A.13, Dr. Lyman raises the issue of the ballooning of the fuel cladding, specifically considering (i) the assumed ductility of the cladding in the MOX fuel LOCA analysis and (ii) the relative ballooning of M5™ cladding. These issues are addressed in Section V.C of our initial testimony (paragraphs 109-114).

48. *(Harvey)* Dr. Lyman's A.12 states: "According to IPSN (now IRSN), results from the PBF-LOC experiments found that irradiated rods experienced greater clad deformation than unirradiated rods during design-basis LOCA conditions. . . . There is simply no way to

determine whether Duke's design-basis LOCA analysis underestimates or overestimates the degree of clad swelling (and hence the degree of fuel relocation) for MOX LTAs without additional experimental data from integral LOCA tests of high-burnup MOX fuel rods." I disagree.

49. *(Harvey)* The PBF test was conducted with irradiated fuel rods that had relatively little burnup. The burnup of the fuel rods ranged from 10.8 to 17.7 GWD/t. In addition, there were a limited number of PBF test rods and only one set of rods (unirradiated v. irradiated) for which the test conditions were similar. It is not appropriate to draw a conclusion about irradiation effects based on this limited set of data. In any case, the PBF test results have been discussed in multiple reports, one of which is NUREG-1230.[2] These reports (including NUREG-1230) attribute the increased cladding strain observed in the PBF test to more uniform temperature distribution around the circumference for the irradiated rods, and not to irradiation effects. It should be pointed out that the Catawba MOX LOCA analysis assumes a uniform temperature distribution around cladding circumference. This assumption conservatively maximizes the calculated cladding strain (ballooning) for all fuel conditions (irradiated and unirradiated).

50. *(Harvey)* Other in-reactor fuel deformation tests were conducted in the FR-2 reactor. The FR-2 tests were conducted for irradiated rods with fuel rod burnups ranging from 2.5 – 35 GWD/t. These tests showed no influence of irradiation damage (*i.e.*, there was no shift in cladding strain with fuel rod exposure). In addition, it has been suggested that the effect of irradiation damage on the cladding are annealed out when the temperatures exceed 700°C (about 1300°F) during the accident.

51. *(Harvey)* In conclusion, the differences between the irradiated and unirradiated tests results at PBF have been explained. Irradiation tests conducted at FR-2 have concluded that there is no significant effect of irradiation damage on cladding strain (ballooning).

52. *(Dunn)* Next, in A.13, Dr. Lyman raises the issue of M5™ cladding that is addressed in Section V.C of our initial testimony. Dr. Lyman testifies that: "According to IRSN, M5 will form larger balloons than Zircaloy-4 in a design-basis LOCA because it remains more ductile during irradiation. October 2003 IRSN presentation to NRC at 24. The greater retained ductility of M5 as a function of burnup compared to Zircaloy-4 can result in a greater M5 balloon size during a design-basis LOCA for fuel rods of the same burnup. Larger balloons increase the space available for fuel fragments to fall and hence result in a greater propensity for fuel relocation during a LOCA, with an associated increase in PCT and local clad oxidation." We have already testified, however, that "there is little expected difference in the consequences of fuel relocation due to cladding differences" (paragraph 114 of our initial direct testimony).

53. *(Dunn)* The ballooning characteristics of the cladding need to be determined from LOCA-relevant ramp tests with increasing cladding temperatures. The IRSN statements quoted by Dr. Lyman are based on constant temperature creep tests. The strain results between these two test types or test conditions vary substantially for either Zircaloy-4 or M5™. This point was the thesis of a paper delivered by Nicolas Waeckel at the meeting at Argonne in May 2004. (NRC Staff Exhibit 4).

54. *(Dunn)* In addition to demonstrating that creep tests cannot be employed to simulate a LOCA, the Waeckel paper compared the available ramp test data from the EDGAR

---

[2] NUREG-1230, "Compendium of ECCS Research for Realistic LOCA Analysis" (December 1988).

test program involving simulated irradiated Zircaloy-4 and M5™ cladding. Irradiated cladding can be simulated by doping fresh cladding with hydrogen. Zircaloy-4 is more ductile for ramp testing than M5™ in its fresh or unirradiated state. However, as shown by Waeckel, when simulated end-of-life (EOL) cladding is tested, the strain data shows only a small reduction in strain for M5™ cladding relative to virgin cladding. There is a larger reduction in strain for Zircaloy-4 cladding in the alpha phase when irradiation effects are simulated. As a result, at EOL conditions the strain developed by the two claddings at rupture is very similar, without significant difference except for phase transition temperatures.

55. *(Dunn)* The NRC Staff addresses this issue in its answer to Question 35 of the Staff direct testimony, and also cites the Waeckel paper (NRC Staff Exhibit 4). The Staff conclusion and associated rationale are consistent with our own.

56. *(Dunn)* Thus, Zircaloy-4 cladding will produce higher strains than M5™ for low irradiation levels but will approach the M5™ strain as the claddings approach EOL conditions. As such, Zircaloy-4 produces a larger ballooned volume into which fuel fragments can relocate for low irradiation cladding and essentially the same relocation volume for highly irradiated cladding. Thus, at the burnup most commonly associated with a real potential for fuel relocation, there is essentially no difference in the ballooned volumes between the two cladding types.

57. *(Nesbit)* In Dr. Lyman's answer to Question 14, he tries to rebut the Waeckel presentation (NRC Staff Exhibit 4). Dr. Lyman acknowledges that a ramp test is more relevant than a creep test, but nonetheless questions the validity of using pre-hydrided but unirradiated cladding material to simulate the performance of irradiated cladding. He notes that M5™ cladding has less oxidation (corrosion) than Zircaloy-4 during normal operation, and he posits that the potential for spalling of Zircaloy-4 at high burnups ". . . will cause spatial

inhomogeneities in the clad temperature that negatively affect ductility, leading to earlier cladding ruptures during a LOCA and hence smaller balloon sizes." He argues, therefore, that: "I don't believe that the EDF presentation fully addresses the differences that would be observed in actual irradiated fuel with regard to the ductility and the balloon size of M5 compared to that of zircaloy-4."

58. *(Nesbit)* Section III.C (paragraphs 48-54) of our testimony points out that AREVA used M5™-specific properties in its evaluation of MOX fuel cladding ballooning and rupture during a design basis LOCA. As we note in Section V.C (paragraph 113) of our testimony, M5™ ductility does not change much with irradiation, relative to Zircaloy-4. Nevertheless, AREVA used unirradiated (most ductile) M5™ properties in order to maximize the extent of ballooning considered in the analysis. Therefore, the AREVA analysis of the MOX fuel lead assemblies maximizes the calculated ballooning and associated flow blockage, consistent with Appendix K. The LOCA analysis showed that the regulatory acceptance criteria are met. Duke fundamentally disagrees with the implication that M5™ cladding introduces unacceptable additional uncertainty with respect to fuel relocation during LOCA.

59. *(Nesbit)* Dr. Lyman in A.14 is clearly — but unnecessarily — concerned about Duke's proposed use of M5™ with MOX fuel. The characteristics that make M5™ an attractive cladding material — low corrosion, retention of ductility with irradiation — seem to be undesirable to BREDL. Dr. Lyman notes that spalling in Zircaloy-4 might lower cladding ductility and lead to an earlier cladding rupture during a postulated design basis LOCA. Such a rupture would limit balloon size and thereby provide unquantified margin with respect to fuel relocation impacts. However, it is *not* preferable to use cladding that might corrode and spall simply because such spalling could be hypothesized to be beneficial during a postulated design

basis LOCA for which regulatory limits are already met. In total context, we do not believe that such an approach would be very prudent.

60. *(Dunn)* Citing BREDL Exhibit K, Dr. Lyman next claims in A.14 that: "The Electric Power Research Institute (EPRI) and Areva (parent company of Framatome ANP) apparently continue to deny NRC access to samples of irradiated high-burnup M5-clad LEU fuel for testing at Argonne National Laboratory. . . . This lack of cooperation can only cause further delays in the ability of NRC to obtain the experimental data it needs to confirm the safety of high-burnup M5-clad fuel (whether LEU or MOX)." While this characterization is largely immaterial to the technical issues raised in Contention I, some response seems warranted.

61. *(Dunn)* First, I find mystifying the assertion concerning a lack of cooperation by AREVA that is developed by Dr. Lyman from the NRC letter to EPRI that is BREDL Exhibit K. The text of the letter alludes to no such "lack of cooperation." AREVA was in fact the first vendor to agree to supply non-irradiated advanced alloy cladding to NRC for LOCA testing. Further, AREVA is currently working with the NRC to develop a mutually acceptable memorandum of understanding (MOU) prescribing the management and conduct of LOCA testing on irradiated M5™ fuel rods. AREVA expects to complete the MOU such that irradiated M5™ fuel rods will be available to the NRC for LOCA research.

62. *(Dunn)* In A.14 Dr. Lyman next claims that: "For some reason, France is reluctant to use M5-clad MOX fuel domestically and is primarily producing it for export to Germany (and now to the United States). However, even in Germany the use of M5-clad MOX has been extremely limited." While again largely immaterial to Contention I, this testimony warrants a response to clarify the record.

63. *(Dunn, Nesbit)* Contrary to the implication in Dr. Lyman's testimony, there is no nefarious reason that French reactors do not extensively use M5™ cladding. The French nuclear industry ("France") is a not a single entity. Framatome ANP is a worldwide fuel vendor, while EDF is the French utility (and a Framatome customer) that operates the French nuclear power plants. The two corporations are separate and have distinct goals. Framatome ANP developed the M5™ advanced cladding alloy to provide for enhanced performance of pressurized water reactor fuel, with an emphasis on high burnups. EDF's current fuel management scheme does not incorporate high burnup to the extent of other Framatome customers. Accordingly, EDF has not yet chosen to deploy advanced cladding materials, including M5™, on a large scale in its nuclear fuel (either LEU or MOX).

64. *(Dunn, Nesbit)* Furthermore, since 1998, 193 MOX fuel assemblies with M5™ cladding have been delivered to four reactors in Germany. This is comparable to the number of M5™-clad LEU fuel assemblies (192) that have been supplied to German reactors in the same time period. While this may seem "extremely limited" to BREDL, it is far more than the number of M5™-clad MOX fuel assemblies that Duke proposes to use at Catawba (four). The total experience base for M5™-clad fuel assemblies is substantial and growing, with more than 3070 such assemblies supplied worldwide, to 41 reactors, through mid-2004.

65. *(Dunn, Nesbit)* To our knowledge, as Dr. Lyman states at the end of A.14, there have been no integral LOCA tests performed on irradiated M5™-clad MOX fuel. For that matter, to our knowledge, there have been no integral LOCA tests performed on irradiated M5™-clad LEU fuel, irradiated Zirlo-clad LEU fuel, irradiated Zircaloy-4-clad LEU fuel with integral absorbers, etc. The performance of integral LOCA tests with irradiated fuel has never been considered a prerequisite for the deployment of fuel designs. If there were such a requirement,

the irradiated fuel would need to come from somewhere (like a lead test assembly program), as we pointed out in Section VI of our initial testimony.

VII. COOLABLE CORE GEOMETRY (A.15)

66. *(Harvey, Dunn)* In our initial testimony, in Section III.C (paragraphs 55-56) we presented the results of relevant MOX fuel LOCA analyses. We specifically testified that: "The maximum calculated cladding strain for the most limiting case is 51 percent and the flow blockage due to this ballooning is 52 percent of the coolant channel surrounding the hot pin. This amount is well within the coolable geometry limit (specified by the AREVA LOCA evaluation model) of 90 percent."

67. *(Harvey)* Dr. Lyman in his A.15 states: "The maximum flow blockage that will preserve the coolable geometry depends on the assumed heat source and the heat transfer properties of the fuel bundle. As IRSN points out, acceptable bundle blockage ratios were derived based upon arrays of unirradiated fuel rods, and did not take into account fuel relocation and its associated impacts on the redistribution of the decay heat source within the fuel rods. IRSN presentation to NRC at 29 (October 23, 2003). . . . Thus, any analysis that does not take this [the impact of relocation in the fuel rod balloon in the flow blockage area] into account is incomplete and is likely to be non-conservative. Lack of consideration of this phenomenon will be of greater concern for the MOX [lead assembly(LTA)] core to the extent that the MOX LTAs have a smaller margin to regulatory limits than LEU fuel." I disagree with this assessment.

68. *(Harvey)* The question about coolability of the blocked region given fuel relocation is not unique to MOX fuel. The only specific tie being made by Dr. Lyman to MOX fuel assemblies is based on the inaccurate statement that the MOX lead assemblies have less margin to the LOCA acceptance criteria than LEU fuel assemblies. In fact, the calculated results for the MOX lead assemblies have more margin to the 10 C.F.R. § 50.46 acceptance criteria than

LEU fuel. The limiting PCT for the MOX fuel LOCA limits calculations is 2019.5°F and the maximum local oxidation value is 5.2%. These values are below the limiting cases for the co-resident LEU fuel in the Catawba core as analyzed by Westinghouse. Thus, this issue raised by Dr. Lyman is not a MOX fuel issue.

69. *(Harvey)* Furthermore, the maximum calculated blockage value for the MOX analysis — 52 percent (*see* paragraph 56 of our initial testimony) is well below the values where core cooling has been demonstrated (90%). Dr. Lyman offers no evidence that fuel relocation will result in a significant change in the ability to cool the fuel assembly following a LOCA. We have addressed the matter of long-term coolability in paragraph 19 of this rebuttal testimony.

VIII. SAFETY MARGINS (A.16)

70. *(Nesbit)* In A.16, Dr. Lyman alleges that safety margins for MOX fuel are smaller than for LEU fuel with respect to PCT following a LOCA. He reiterates many of the arguments made before; as before, however, the discussion is fundamentally flawed in several key respects.

71. *(Nesbit)* First, Dr. Lyman states that "As Duke's calculations have demonstrated, the PCT in a design-basis LOCA is higher for a MOX rod than for an LEU rod in the same position in the core. . . . The margin to the 10 C.F.R. § 50.46 PCT limit of 2200°F is therefore smaller for a MOX rod than for an LEU rod in the same position." As we point out in Section III.C (paragraph 58) of our initial testimony, the difference in the "apples to apples" PCT (less than 40°F) is insignificant in the context of Appendix K design basis LOCA calculations. Furthermore, as we have noted several times, we chose not to take credit for some MOX/LEU differences that would, in all likelihood, reduce the MOX fuel PCT below that of LEU fuel. Fundamentally, Duke's analyses demonstrate that MOX fuel and LEU fuel PCTs following LOCA are essentially the same.

72. *(Nesbit)* Second, Dr. Lyman alleges that: "At high burnups, the linear heat generation rate for MOX fuel is generally higher than that for LEU fuel. This, in turn, results in increased centerline temperature and stored energy, therefore reducing the margin to design-basis LOCA regulatory limits." This "fact" is apparently based on statements by IRSN researchers; again, however, BREDL has not offered the originator of this statement as a witness, so we have no opportunity to critically examine the basis for the statement. The statement appears to be based on an aspect of European MOX fuel that is different from the weapons grade MOX fuel that is proposed for use at Catawba. As we make clear in Section V.F (paragraphs 129-142) of our initial testimony, the MOX fuel lead assemblies will operate at a linear heat generation rate that is lower than the peak (and at almost all burnups, the average) for co-resident LEU fuel assemblies in the same cycle of operation. The MOX/LEU difference in linear heat generation rate cited by BREDL is actually a benefit, not a penalty, for the Catawba MOX fuel lead assemblies.

73. *(Nesbit)* Third, Dr. Lyman's approach of simplistically superimposing a PCT increase of 313°F on a reported MOX fuel PCT of 2018°F is incorrect. The PCT increase of 313°F was obtained from an IRSN calculation reported at Aix-en-Provence in 2001, and it was based on a high filling fraction (70%). The presenter of the information admitted that the calculation took no credit for the cooling benefits of ballooning and rupture[3], which, as noted in Section V.A (paragraphs 90-98) of our previous testimony, are substantial. Furthermore, any impact of relocation on cladding temperature would necessarily take place at the location

---

[3] Grandjean, C., et al., "High Burnup UO2 Fuel LOCA Calculations to Evaluate the Possible Impact of Fuel Relocation After Burst," NEA/CSNI/R(2001)18, Aix-en-Provence, March 2001 (Duke Exhibit 4; see "Discussion" following paper and presentation material).

(elevation) of the ballooning and rupture. Modeling relocation effects would not adversely affect cladding temperatures at other (non-ruptured) elevations on the fuel rod. It is inappropriate to add a ΔPCT estimated for relocation to a calculated PCT at a non-ruptured location, as Dr. Lyman did in paragraph 4 of A.16. For the Appendix K LOCA analyses that actually formed the basis for the MOX fuel lead assembly LOCA limits[4], the highest *ruptured node* temperature was 1750°F, as stated in Section III.C (paragraph 55) of our testimony. Therefore, an appropriate bound of the potential relocation effect would add the very conservative IRSN ΔPCT to the highest *ruptured node* temperature. As noted in Section V.G (paragraph 154) of our testimony, this produces a value of 2070°F, well below the 2200°F PCT regulatory limit in 10 C.F.R. § 50.46. Again, BREDL has misconstrued the available information on fuel relocation and PCT, and provided an erroneous assessment of the potential impact on MOX fuel lead assemblies. The statement in A. 16 that "... the MOX LTAs could well be limiting with respect to LOCA compliance if relocation is fully accounted for" has no basis.

74. *(Nesbit)* Finally, contrary to Dr. Lyman's point in the last paragraph of A.16, there are no "significant uncertainties" that warrant NRC disapproval of the MOX fuel lead assembly program. Our testimony makes it clear that the uncertainty in calculated, post-LOCA PCT and cladding oxidation for the MOX fuel lead assemblies is essentially the same as the corresponding uncertainty in LEU fuel calculations. Furthermore, our testimony points out (i) the inherent conservatism in Appendix K LOCA analyses, and (ii) the substantial margin between actual plant operation and the LOCA limits.

---

[4] Duke Energy response to NRC Requests for Additional Information, November 3, 2003, (Duke Exhibit 2; see Table Q14-1).

IX. "GAPS IN THE EXPERIMENTAL DATABASE" (A. 17)

75. *(Nesbit)* Dr. Lyman states in A.17 that: "The only way to fully address the uncertainties associated with the behavior of high-burnup, M5-clad MOX fuel during LOCAs is to conduct integral LOCA tests of such fuel, fabricated with the same specifications as the lead test assemblies that are under consideration here, and irradiated to a range of burnups, including the maximum of 60 GWD/t that Duke has requested in its LAR. The proposed Phébus test series would likely make a substantial contribution to reducing the level of uncertainty associated with MOX fuel behavior during LOCAs." Dr. Lyman goes on to suggest that these integral tests could be supplemented by separate effects tests such as are currently planned at Halden for LEU fuel, but he believes that ". . . similar (separate effects) tests on mixed oxide fuel will also be needed." Dr. Lyman has also previously stated[5] that the proposed MOX fuel tests could be carried out with European reactor grade MOX fuel, provided that some combination of tests and analyses were to address unspecified effects associated with the isotopic difference between European reactor grade MOX fuel and the weapons grade MOX fuel that will be used at Catawba. It is evident that, in Dr. Lyman's view, a major experimental and analytical program must be completed prior to using MOX fuel, even in a limited demonstration exercise (*e.g.*, four lead assemblies at Catawba).

76. *(Nesbit)* The arguments against the use of MOX fuel lead assemblies at Catawba are based solely on purported uncertainties associated with fuel relocation and advanced cladding materials, which we have already discussed. Despite BREDL attempts to tie the fuel relocation issue to alleged differences between MOX and LEU fuel, the relocation issue is just as applicable to the range of currently-deployed LEU fuel designs as it is to the MOX fuel lead assemblies. Dr. Lyman's cladding based concerns are clearly applicable to the numerous United States

---

5 BREDL Response to Duke Energy Corporations First Set of Interrogatories and Requests for Production of Documents, April 14, 2004 (see response to Interrogatory 15).

nuclear power plants that use M5™ and Zirlo™ cladding with LEU fuel. The NRC has quite obviously concluded that these purported uncertainties are not too great with respect to the ongoing use of LEU fuel in millions of fuel rods at more than one hundred United States nuclear power reactors.

77. *(Nesbit)* BREDL would establish an impossibly high and completely unnecessary standard for conducting lead test assembly programs. We address this point in some detail in Section VI (paragraphs 158-171) of our prior testimony. The purpose of lead test assemblies is to gather information prior to large-scale deployment of a new or revised fuel design in nuclear power reactors. This process has worked well over the past decades, and nuclear fuel designs have evolved greatly, with substantial performance and environmental benefits. MOX fuel lead assemblies are a key element in the overall program to dispose of surplus weapons grade plutonium in the United States and in Russia. Thus, this lead assembly program will provide benefits associated with achieving nonproliferation policy objectives of the United States government and the international community.

X. CONCLUSION

78. *(All)* We have shown that the MOX fuel lead assemblies can be used in conformance with regulatory requirements and without posing an undue threat to the health and safety of the public.