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May 7, 2008

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U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Catawba Nuclear Station Units 1&2, Docket Nos. 50-413, 50-414
McGuire Nuclear Station Units 1&2, Docket Nos. 50-369, 50-370

Subject: Duke Energy Carolinas, LLC (Duke)
Proposed Amendments to the Renewed Facility Operating Licenses and Technical Specifications Pursuant to the Use of Advanced Mark-BW (ABW) Fuel and Request for Exemption from Certain Regulations in 10 CFR Part 50

Pursuant to 10 CFR 50.90, Duke hereby requests a license amendment to revise Unit 1 and 2 Technical Specification 4.2.1 for the Catawba and McGuire Nuclear Stations. The proposed changes are necessary to allow the use of nuclear fuel clad with the M5™ zirconium-based alloy. Enclosure 1 to this letter provides a technical and regulatory evaluation of the changes. Proposed technical specification page markups and retyped pages are included as attachments to Enclosure 1.

Pursuant to 10 CFR 50.12, Duke also requests exemptions from certain requirements of 10 CFR 50.46 "*Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors*" and Appendix K to 10 CFR 50. The exemptions requested relate solely to the specific types of cladding material specified in these regulations. As written, these regulations presume the use of Zircaloy or ZIRLO™ fuel rod cladding. These exemptions are necessary to allow the use of M5™ clad fuel at Catawba and McGuire. Enclosure 2 to this letter is the request for exemptions and the associated technical justification for those exemptions.

Duke plans to insert four AREVA NP Advanced Mark-BW (ABW) lead test assemblies (LTAs) in Catawba Unit 2 Cycle 17 in March 2009. The Catawba LTA program will allow completion of two cycles of LTA irradiation prior to batch use of ABW fuel, which is planned for late 2012 at Catawba Unit 1. Duke also plans to insert eight ABW LTAs in McGuire Unit 2 Cycle 20 in September 2009, in order to gain ABW operating experience at McGuire prior to batch use of the fuel design (planned for McGuire Unit 1 in 2013). The ABW fuel incorporates M5™ cladding, so the technical specification changes and exemptions that are requested herein are needed to support the Catawba ABW LTAs in March 2009, the McGuire ABW LTAs in September 2009, and subsequent batch use of ABW fuel at all Catawba and McGuire units.

Duke requests that the NRC approve these proposed amendments and issue the requested exemptions by January 12, 2009 to support the insertion of ABW LTAs during the spring 2009

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refueling outage for Catawba Unit 2. Duke will implement the amendments within 30 days of the NRC approval date.

It is noted that batch use of ABW fuel at Catawba and McGuire will require additional technical specification changes beyond those requested herein. Duke plans to submit the additional McGuire and Catawba technical specification changes to the NRC at a later date.

Implementation of these amendments to the McGuire facility operating license and technical specifications will not impact the McGuire Updated Final Safety Analysis Report (UFSAR). However, the wording of Catawba Technical Specification 4.2.1 is currently reflected in the last paragraph of UFSAR Section 4.2.1. Accordingly, Duke will modify Catawba UFSAR Section 4.2.1 once the amendment is approved. In addition, Duke plans to add a description of the ABW LTAs to Section 4.3.2 of the UFSARs of both plants.

This letter and Enclosure 1 contain regulatory commitments, which are documented in Attachment 2 to Enclosure 1.

In accordance with Duke administrative procedures and the Quality Assurance Program Topical Report, these proposed amendments have been previously reviewed and approved by the Catawba and McGuire Plant Operations Review Committees and the Duke Nuclear Safety Review Board.

Pursuant to 10 CFR 50.91, copies of these proposed amendments are being sent to the appropriate state officials.

If there are any questions or if additional information is needed, please contact Mr. L. J. Rudy at (803) 831-3084 or ljrudy@dukeenergy.com.

Very truly yours,

J. R. Morris

LJR/s

Enclosures: (1) License Amendment Request
(2) Request for Exemption

J. R. Morris affirms that he is the person who subscribed his name to the foregoing statement, and that all statements and matters set forth herein are true and correct to the best of his knowledge.

J. R. Morris, Site Vice President

Subscribed and sworn to me: 5/7/08
Date

Notary Public

My commission expires: 7/2/2014
Date

SEAL

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ENCLOSURE 1

License Amendment Request

Subject: **Application for License Amendment to Revise Technical Specification 4.2.1 to Allow Use of M5™ Clad Fuel**

1. DESCRIPTION

2. TECHNICAL EVALUATION

   2.1 M5™ Cladding
   2.2 ABW LTA Program

3. REGULATORY EVALUATION

   3.1 Applicable Regulatory Requirements/Criteria
   3.2 Precedents
   3.3 Significant Hazards Consideration
   3.4 Conclusions

4. ENVIRONMENTAL CONSIDERATION

5. REFERENCES

ATTACHMENTS:

1. Description of ABW LTA Program
2. List of Regulatory Commitments
3. Catawba Technical Specification Page Markup
4. Retyped Catawba Technical Specification Page
5. McGuire Technical Specification Page Markup
6. Retyped McGuire Technical Specification Page

1. DESCRIPTION

This evaluation supports a request to revise the Renewed Facility Operating Licenses for Catawba Units 1 and 2 and for McGuire Units 1 and 2 to allow the use of M5™ clad fuel. M5™ is an advanced zirconium-based alloy that has been successfully deployed in numerous nuclear power reactors in the United States and abroad.

The AREVA NP Advanced Mark-BW (ABW) nuclear fuel design incorporates M5™ cladding. Duke plans to deploy four ABW lead test assemblies (LTAs) in Catawba Unit 2 Cycle 17 in March 2009 and eight ABW LTAs in McGuire Unit 2 Cycle 20 in September 2009. Duke intends to begin batch deployment of ABW fuel at Catawba beginning in late 2012 and at McGuire in early 2013. The license amendments requested herein, along with the associated exemption requests, are necessary to support the use of ABW fuel with M5™ cladding (including the planned LTA program). Additional license amendments and methodology report approvals will be required to support batch deployment of ABW fuel. Duke will request those additional approvals through separate licensing actions that are not addressed in this submittal.

The specific technical specification change for both Catawba and McGuire Nuclear Stations is shown below.

4.2.1 Fuel Assemblies

> The reactor shall contain 193 fuel assemblies. Each assembly shall consist of a matrix of either ZIRLO™**, M5™,** or ~~Zircalloy~~ **Zircaloy** fuel rods with an initial composition of natural or slightly enriched uranium dioxide (UO_2) as fuel material. ....

2. TECHNICAL EVALUATION

2.1 M5™ Cladding

The existing Technical Specification 4.2.1 identifies nuclear fuel cladding materials, including the one used in the current Westinghouse RFA fuel (i.e., ZIRLO™ cladding). The revision adds M5™ cladding to the description of fuel cladding materials. M5™ is the cladding material used in AREVA NP ABW fuel, which Duke plans to use at the Catawba and McGuire Nuclear Stations. Also, as part of this technical specification change "Zircalloy" is revised to "Zircaloy", the customary spelling [e.g., 10 CFR 50.46(a)(1)(i)].

M5™ has desirable cladding performance characteristics. As noted by the NRC in the Safety Evaluation attached to Reference 1:

> M5 is an alloy comprised primarily of zirconium (~99 percent) and niobium (~1 percent). The elimination of tin in M5 has resulted in superior corrosion resistance and reduced irradiation-induced growth relative to both standard zircaloy (1.7% tin) and low-tin zircaloy (1.2% tin). The addition of niobium increases ductility, which is desirable to avoid brittle failures.

The use of M5™ is supported by extensive testing and analyses, as documented in the NRC-approved AREVA NP topical report BAW-10227P-A, *Evaluation of Advanced Cladding and Structural Material (M5™) in PWR Reactor Fuel* (Reference 2). BAW-10227P-A addresses the performance of M5™ cladding under both normal operating and accident conditions. The associated NRC Safety Evaluation (Reference 3, p. 31) states the following:

> The NRC staff concludes that the M5 properties and mechanical design methodology, as defined in BAW-10227P ... are in accordance with SRP Section 4.2, 10 CFR 50.46, and 10 CFR 50 Appendix K and, therefore, are acceptable for fuel reload licensing applications up to rod average burnup levels of 62,000 MWd/MTU and 60,000 MWd/MTU[1] for Mark B and Mark-BW fuel designs, respectively.

Moreover, M5™ is a proven cladding material that has been in use for years in nuclear power reactors in the United States and overseas. Within the United States, these reactors include the Catawba Nuclear Station Unit 1[2], the Oconee Nuclear Station, the North Anna Nuclear Power Station, the Davis Besse Nuclear Power Station, Three Mile Island Unit 1, Arkansas Nuclear One Unit 1, Crystal River Unit 3, and the Sequoyah Nuclear Plant. In each instance the NRC has reviewed and approved the use of M5™. Sequoyah has a four-loop Westinghouse-designed nuclear steam supply system (NSSS), like Catawba and McGuire. Both North Anna and

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1 The June 18, 2003 Safety Evaluation of AREVA NP Topical Report BAW-10186P-A, Revision 1, Supplement 1, *Extended Burnup Evaluation* (Reference 4) approved the extension of the Mark-BW fuel rod burnup limit to 62,000 MWd/MTU.

2 M5™ is used in the mixed oxide fuel lead assemblies which are currently in their second cycle of irradiation at Catawba Unit 1. However, that authorization to use M5™ cladding at Catawba (Reference 5) is limited to the MOX fuel lead assembly program.

Sequoyah use 17x17 fuel assemblies, as are used at Catawba and McGuire. Worldwide, fuel assemblies with M5™ cladding have been used in 56 reactors in 11 countries.

2.2 ABW LTA Program

Nuclear power reactor technical specifications typically do not address specific fuel designs, and the Technical Specification 4.2.1 change being sought by Duke relates to cladding material (M5™), not to the ABW LTA program. However, Duke anticipates that NRC will desire information on the planned LTA program and the ABW fuel design. Accordingly, a description of the ABW LTA program is provided for information in Attachment 1 to this Technical Justification.

3. REGULATORY EVALUATION

3.1 Applicable Regulatory Requirements/Criteria

The proposed change has been evaluated to determine whether applicable regulations and requirements are met.

10 CFR 50, Appendix A provides general design criteria for nuclear power plants. Criterion 10 "Reactor design" (restated below) is applicable to the fuel rod cladding.

> The reactor core and associated coolant, control, and protection systems shall be designed with appropriate margin to assure that specified acceptable fuel design limits are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences.

The Standard Review Plan (SRP) Section 4.2 (Reference 6) provides NRC regulatory guidance related to fuel rod cladding. Among other things, SRP 4.2 provides acceptance criteria for the cladding during normal operation, anticipated operational occurrences, and accident conditions.

10 CFR 50.46 provides acceptance criteria for emergency core cooling systems for light-water nuclear power reactors. 10 CFR 50 Appendix K defines required and acceptable features of loss of coolant accident evaluation models used in accordance with 10 CFR 50.46(a)(1)(ii). Duke has determined that the use of M5™ fuel rod cladding material requires exemptions from 10 CFR 50.46 and 10 CFR 50 Appendix K. Accordingly, in Enclosure 2 of this submittal Duke is requesting exemptions from those regulations.

3.2 Precedents

The NRC has modified the technical specifications of other United States nuclear power reactors to allow for the use of M5™ cladding, as noted in the following table.

Reactor	NSSS Design	Fuel Design	NRC Approval Date
Davis Besse Unit 1	Babcock & Wilcox	15x15	March 15, 2000
Oconee Units 1, 2, and 3	Babcock & Wilcox	15x15	June 21, 2000
Sequoyah Units 1 and 2	Four loop Westinghouse	17x17	July 31, 2000
Three Mile Island Unit 1	Babcock & Wilcox	15x15	May 10, 2001
Calvert Cliffs Unit 2*	Combustion Engineering	14x14	April 14, 2003
Crystal River Unit 3	Babcock & Wilcox	15x15	October 1, 2003
North Anna Units 1 and 2	Three loop Westinghouse	17x17	April 1, 2004 (Unit 2) August 20, 2004 (Unit 1)
Catawba Units 1 and 2*	Four loop Westinghouse	17x17	March 3, 2005
Arkansas Nuclear One Unit 1	Babcock & Wilcox	15x15	September 12, 2005
Fort Calhoun Unit 1	Combustion Engineering	14x14	August 30, 2006
Braidwood Units 1 and 2*	Four loop Westinghouse	17x17	October 4, 2007

* LTAs only

3.3 Significant Hazards Consideration

The proposed amendments would (i) allow the use of M5™ fuel rod cladding for Catawba Units 1 and 2 and for McGuire Units 1 and 2, and (ii) correct the spelling of "Zircaloy". The spelling change is administrative and clearly poses no significant hazard. Duke has evaluated the substantive aspects of the proposed change to Technical Specification 4.2.1 to determine whether or not the change involves a significant hazards consideration per 10 CFR 50.92. As described below, Duke concludes that the change does not meet any of the three criteria for a significant hazards consideration.

Does the proposed change involve a significant increase in the probability or consequences of an accident previously evaluated?

No. The NRC-approved topical report BAW-10227P-A, *Evaluation of Advanced Cladding and Structural Material (M5) in PWR Reactor Fuel* (Reference 2) demonstrates that M5™ has acceptable properties for use in nuclear fuel rod cladding. The cladding material is not an accident initiator and does not affect accident probability. Fuel rod cladding has the potential to affect accident consequences through cladding failure. In Sections 4 and 5 of the Safety Evaluation of BAW-10227P-A (Reference 3), the NRC evaluated the performance of M5™ cladding under accident conditions and found it to be acceptable. Accordingly, use of M5™ will not result in a significant increase in the probability or consequences of an accident previously evaluated.

Does the proposed change create the possibility of a new or different kind of accident from any accident previously evaluated?

No. The use of M5™ cladding does not change how the plant is operated. The NRC-approved topical report BAW-10227P-A, *Evaluation of Advanced Cladding and Structural Material (M5) in PWR Reactor Fuel* (Reference 2) demonstrates that M5™ has acceptable properties for use in nuclear fuel rod cladding. M5™ is a predominantly zirconium alloy, as are Zircaloy and ZIRLO™. M5™ has been shown to perform similarly to Zircaloy, with superior performance in areas such as corrosion resistance. Therefore, the use of M5™ for fuel rod cladding will not create the possibility of a new or different kind of accident from those previously evaluated.

Does the proposed change involve a significant reduction in a margin of safety?

No. The use of M5™ cladding does not change accident acceptance criteria. NRC-approved topical report BAW-10227P-A, *Evaluation of Advanced Cladding and Structural Material (M5) in PWR Reactor Fuel* (Reference 2) demonstrates that M5™ has acceptable properties for use in nuclear fuel rod cladding. Therefore, M5™ fuel rod cladding can be used without a significant reduction in the margin of safety.

3.4 Conclusions

In conclusion, based on the considerations discussed above, (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner,

(2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendments will not be inimical to the common defense and security or to the health and safety of the public.

4. ENVIRONMENTAL CONSIDERATION

The proposed amendments do not involve (i) a significant hazards consideration, (ii) a significant change in the types or a significant increase in the amounts of any effluents that may be released offsite, or (iii) a significant increase in individual or cumulative occupational radiation exposure. Accordingly, the proposed amendments meet the eligibility criterion for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the proposed amendments.

5. REFERENCES (Enclosure 1 and all attachments thereto)

1. Letter, M. C. Thadani (NRC) to J. S. Forbes (Entergy), Arkansas Nuclear One, Unit 1 - Issuance of Amendment Re: Use of M5 Fuel Cladding and Mark-B High Thermal Performance Fuel, September 12, 2005.
2. BAW-10227P-A, *Evaluation of Advanced Cladding and Structural Material (M5™) in PWR Reactor Fuel*, Revision 1, AREVA NP, June 2003.
3. Letter, S. A. Richards (NRC) to T. A. Coleman (Framatome Cogema Fuels), Revised Safety Evaluation (SE) for Topical Report BAW-10227P: "Evaluation of Advanced Cladding and Structural Material (M5) in PWR Reactor Fuel," February 4, 2000.
4. Letter, H. N. Berkow (NRC) to J. F. Mallay (Framatome ANP), Safety Evaluation of Framatome ANP Topical Report BAW-10186P-A, Revision 1, Supplement 1, "Extended Burnup Evaluation," June 18, 2003.
5. Letter, R. E. Martin, Sr. (NRC) to H. B. Barron (Duke), Catawba Nuclear Station, Units 1 and 2 Re: Issuance of Amendments, March 3, 2005.
6. NUREG-0800, United States Nuclear Regulatory Commission Standard Review Plan, Revision 3, March 2007.
7. BAW-10239(P)-A, *Advanced Mark-BW Fuel Assembly Mechanical Design Topical Report*, AREVA NP, July 2004.
8. Letter, H. N. Berkow (NRC) to J. F. Mallay (Framatome ANP), Final Safety Evaluation for Framatome ANP Topical Report BAW-10239(P), Revision 0, "Advanced Mark-BW Fuel Assembly Mechanical Design Topical Report," July 1, 2004.
9. DPC-NE-1005-P-A, Revision 0, *Nuclear Design Methodology Using CASMO-4 / SIMULATE-3 MOX*, Duke Power, August 2004.
10. Letter, T. C. Geer (Duke) to U. S. Nuclear Regulatory Commission, License Amendment Request Revising Methodology Report DPC-NE-1005-P-A, Revision 0, *Nuclear Design Methodology Using CASMO-4/SIMULATE-3 MOX* (Proprietary), November 12, 2007.
11. BAW-10162P-A, *TACO3 Fuel Pin Thermal Analysis Computer Code*, AREVA NP, October 1989.
12. BAW-10084, Revision 2, *Program to Determine In-Reactor Performance of B&W Fuels - Cladding Creep Collapse*, AREVA, October 1978.
13. DPC-NE-2008P-A, *Duke Power Company Fuel Rod Mechanical Reload Analysis Methodology Using TACO3*, Duke Power Company, April 1995.
14. BAW-10184P-A, *GDTACO – Urania Gadolinia Fuel Pin Thermal Analysis Code*, AREVA NP, February 1995.
15. Letter, A. C. Thadani (NRC) to J. H. Taylor (B&W Nuclear Technologies), Acceptance for Referencing of Topical Report BAW-10184P, "GDTACO - Urania Gadolinia Fuel Pin Thermal Analysis Code," June 24, 1993.
16. DPC-NE-2004-PA, Revision 1, *McGuire and Catawba Nuclear Stations Core Thermal-Hydraulic Methodology Using VIPRE-01*, February 1997.

17. BAW-10199P-A, Addendum 2, *Application of the BWU-Z CHF Correlation to the Mark-BW17 Fuel Design with Mid-Span Mixing Grids*, AREVA NP, June 2002.

18. BAW-10199P-A, The BWU Critical Heat Flux Correlations, AREVA NP, August 1996.

19. DPC-NE-2005-PA, Revision 3, *Thermal-Hydraulic Statistical Core Design Methodology*, Duke Power Company, September 2002.

20. DPC-NE-3000-PA, Revision 3, *Thermal-Hydraulic Transient Analysis Methodology*, Duke Power Company, September 2004.

21. DPC-NE-3001-PA, *Multidimensional Reactor Transients and Safety Analysis Physics Parameters Methodology*, Duke Power Company, December 2000.

22. DPC-NE-3002-A, Revision 4, *UFSAR Chapter 15 System Transient Analysis Methodology*, Duke Power Company, May 2005.

23. DPC-NE-2009P-A, Revision 2, *Westinghouse Fuel Transition Report*, Duke Power Company, December 2002.

24. Letter, J. F. Stang (NRC) to D. Jamil (Duke), Catawba Nuclear Station Units 1 and 2 Issuance of Amendments Regarding Revised Storage Criteria for Low-Enriched Uranium Fuel, September 27, 2006.

25. Letter, J. Shea (NRC) to G. R. Peterson (Duke), McGuire Nuclear Station Units 1 and 2 Issuance of Amendments, March 17, 2005.

26. Generic Letter 2004-02, *Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents and Pressurized Water Reactors*, Nuclear Regulatory Commission, September 13, 2004.

27. Letter, J. R. Morris (Duke) to U. S. Nuclear Regulatory Commission, Catawba Nuclear Station - NRC Generic Letter 2004-02, February 29, 2008.

28. Letter, B. H. Hamilton (Duke) to U. S. Nuclear Regulatory Commission, McGuire Nuclear Station - NRC Generic Letter 2004-02, February 28, 2008.

ATTACHMENT 1

Description of ABW LTA Program

A1.0 Description

Duke plans to transition to AREVA NP ABW fuel in the McGuire and Catawba reactors, beginning with Catawba Unit 1 in late 2012 and McGuire Unit 1 in early 2013. In support of that transition, Duke plans to conduct LTA programs beginning with Catawba Unit 2 Cycle 17 (Spring 2009 startup) and McGuire Unit 2 Cycle 20 (Fall 2009 startup). These planned LTA programs will result in multiple cycles of LTA operation prior to batch deployment in McGuire and Catawba. Thus, the LTA programs will provide added assurance of reliable fuel operation when the batch fuel transition occurs.

Duke plans to load four ABW LTAs in Catawba Unit 2 and eight ABW LTAs in McGuire Unit 2, and to use all of the LTAs for at least two cycles of operation. Consistent with Technical Specification 4.2.1, the LTAs will be placed in non-limiting core locations. Duke intends to conduct poolside post-irradiation examination after each cycle of LTA operation in order to verify that the assemblies perform as expected. The planned examinations include detailed visual inspections and fuel assembly growth measurements as well as water channel (fuel rod bow) measurements after the second cycle of irradiation.

Both the Catawba Unit 2 core and the McGuire Unit 2 core are currently comprised exclusively of Westinghouse Robust Fuel Assembly (RFA) fuel. There are no other LTA programs ongoing in the Catawba Unit 2 core, and no other LTAs will be inserted into Catawba 2 Cycle 17 (Spring 2009 startup). Similarly, there are no other LTA programs ongoing in the McGuire Unit 2 core, and no other LTAs will be inserted into McGuire 2 Cycle 20 (Fall 2009 startup).

A2.0 ABW LTA Design

The AREVA NP ABW fuel assembly design to be used in the Catawba and McGuire LTA programs is a 17x17 lattice with M5™ cladding, instrument tube, and guide tubes. The intermediate grids and mid-span mixing grids are also made of M5™. The end grids are made of Inconel 718, and the upper and lower end fittings are made of stainless steel. The fuel rod nominal diameter is 0.374 inches, and the cladding nominal thickness is 0.0225 inches.

The ABW LTA is shown on Figure 1. LTA design information is shown in Table 1, along with information for the co-resident RFA fuel.

The AREVA NP topical report for the ABW fuel assembly mechanical design is BAW-10239(P)-A (Reference 7). The NRC Safety Evaluation for Reference 7 was issued on July 1, 2004 (Reference 8). The ABW design is approved for a fuel rod average burnup of 62 GWd/MTU (Reference 4).

In one respect the Catawba and McGuire LTAs will be different from the design described in Reference 7, Section 3. The lowest intermediate grid will be a mixing vane grid rather than a non-mixing vane grid. This change provides improved thermal margin.

Duke plans to incorporate an integral gadolinium oxide (gadolinia) neutron burnable absorber material in the fuel pellets of up to 28 fuel rods per ABW LTA. The neutronic implications of gadolinia are addressed in Section A3.1 below.

A3.0 LTA Core Reload Design

With the exception of Loss-of-Coolant Accident (LOCA) analysis which is performed by the fuel vendor, Duke performs the reload design work for the Catawba and McGuire units inhouse, using NRC-approved methods. The reload analyses ensure that the fuel meets applicable limits during steady state operations and postulated Updated Final Safety Analysis Report (UFSAR) Chapter 15 design basis transients and accidents.

Technical Specification 4.2.1 provides regulatory authorization for LTA programs, provided that the LTAs are loaded in non-limiting core regions (i.e., locations). The latter portion of McGuire and Catawba Technical Specification 4.2.1 states the following.

> Fuel assemblies shall be limited to those fuel designs that have been analyzed with applicable NRC staff approved codes and methods. A limited number of lead test assemblies that have not completed representative testing may be placed in nonlimiting core locations.

Duke and AREVA NP will analyze the ABW LTAs as part of the reload design process to ensure that the fuel meets all applicable design and regulatory limits, as summarized in Sections A3.1 through A3.5 below. The reload analyses will be based on NRC-approved Duke and AREVA NP methodologies. However, as is typical for a LTA program, some of the methods specific to the ABW fuel design and to gadolinia are not yet incorporated in the approved Duke methodology reports. Those instances are specifically identified and addressed in Sections A3.1 through A3.5. The reload design analyses will include consideration of mixed core effects, i.e., impact of the ABW LTAs on the co-resident RFA fuel and vice versa.

A3.1 Core Physics

Duke will apply its standard core reload design methodology to the cores that incorporate ABW LTAs. The computer codes used for the calculation of core power distributions and physics parameters are described and validated for McGuire and Catawba applications in the NRC-approved Duke methodology report DPC-NE-1005-P-A, Revision 0, *Nuclear Design Methodology Using CASMO-4 / SIMULATE-3 MOX* (Reference 9). Duke anticipates that each of the ABW LTAs will contain up to 28 fuel rods with integral gadolinia absorber. Revision 1 of DPC-NE-1005-P validates the CASMO-4 and SIMULATE-3 MOX computer codes for the analysis of gadolinia fuel rods and calculates nuclear uncertainty factors for gadolinia fuel rods. Revision 1 has been submitted to the NRC for review and approval (Reference 10), but the review has not yet been completed.

Calculated ABW LTA powers will be compared to power limits specifically derived for (or shown to be conservative for) those LTAs. The development of those ABW LTA limits is discussed later in this section (see Sections A3.2 through A3.5 addressing fuel rod mechanical design, core thermal-hydraulic design, UFSAR Chapter 15 non-LOCA transient and accident analyses, and LOCA analyses, respectively). Gadolinia-specific nuclear uncertainty factors from Reference 10 will be applied to gadolinia rods.

The core physics analyses address a mixed core containing LTAs. The CASMO-4 and SIMULATE-3 MOX models explicitly address each fuel type - the ABW LTAs and the co-resident Westinghouse RFA fuel. When comparing calculated powers to power limits, nuclear uncertainty factors appropriate to each fuel rod (i.e., with or without integral gadolinia) will be applied.

A3.2 Fuel Rod Mechanical Design

Duke will perform fuel rod mechanical and thermal assessments of the ABW LTAs using AREVA NP NRC-approved methods. Most of the fuel rods in each LTA will have pellets comprised of uranium dioxide (UO_2), and those rods will be analyzed using the NRC-approved AREVA NP TACO3 computer code (Reference 11)[3] as described in the Duke methodology report DPC-NE-2008P-A, *Duke Power Company Fuel Rod Mechanical Reload Analysis Methodology Using TACO3* (Reference 13). The fuel rod analyses establish fuel rod power (kW/ft) limits that ensure that centerline fuel melt and cladding strain limits are not exceeded. The fuel rod analyses also verify that fuel rod internal pressure, creep collapse, and corrosion criteria are met.

As noted in Section A3.1, up to 28 fuel rods per ABW LTA may include gadolinia in the fuel pellets as an integral neutron burnable absorber. Duke will use the NRC-approved AREVA NP GDTACO computer code (Reference 14) to analyze the fuel rods that contain gadolinia pellets. Duke will use the GDTACO code in the same manner in which the TACO3 code is applied[4].

Duke will comply with the restrictions in the NRC Safety Evaluation for the GDTACO code (Reference 15). Specifically, Duke will limit the fuel gadolinia concentrations to 8 weight per cent or less, and Duke will perform cycle-specific analyses for each reload. Duke will comply with the second restriction by performing generic fuel rod mechanical analyses and ensuring that the generic analyses are applicable to the calculated ABW LTA powers for each fuel operating cycle. If the ABW LTA fuel operating characteristics are not bounded by the generic analyses, then cycle-specific analyses will be performed to verify that the fuel rod design criteria are met.

There are no mixed core effects related to fuel rod mechanical analyses. Each fuel rod type is evaluated using methods appropriate for that rod. In the case of the ABW LTAs, the TACO3

3 TACO3 is used for most analyses, but the cladding creep collapse evaluation uses the CROV computer code (Reference 12), as described in DPC-NE-2008P-A (Reference 13).

4 The Duke fuel rod mechanical analysis methodology report DPC-NE-2008P-A (Reference 13) does not currently include GDTACO methods for gadolinia fuel rod analyses.

methodology will be used for UO_2 fuel rods, and GDTACO will be used for rods with fuel pellets containing gadolinia.

A3.3 Core Thermal-Hydraulic Design

Duke performs core thermal-hydraulic analyses to preclude the occurrence of departure from nucleate boiling (DNB) during steady-state operation. The Duke methodology uses the VIPRE-01 computer code as described in the NRC-approved Duke report DPC-NE-2004-PA - *McGuire and Catawba Nuclear Stations Core Thermal-Hydraulic Methodology using VIPRE-01* (Reference 16). Duke will use the NRC-approved AREVA NP BWU-Z/MSM critical heat flux (CHF) correlation (Reference 17) for elevations at and above the first mixing vane grid. Duke will apply the NRC-approved BWU-N CHF correlation (Reference 18) below the first mixing vane grid.

The NRC-approved Duke report DPC-NE-2005P-A, *Thermal-Hydraulic Statistical Core Design Methodology* (Reference 19), describes the VIPRE-01 methodology for the statistical combination of the uncertainties related to the calculation of the DNB ratio (DNBR). The appendices of DPC-NE-2005P-A present the application of the methodology to the calculation of a statistical DNBR design limit for specific fuel assembly designs and CHF correlations. Appendix E of DPC-NE-2005P-A applies to the ABW design with a lowermost non-mixing vane intermediate grid and five mixing vane intermediate grids (the design of the four MOX fuel lead assemblies in Catawba Unit 1). The ABW LTAs that are planned for insertion into Catawba Unit 2 and McGuire Unit 2 in 2009 have six intermediate mixing vane grids. Additional analyses will confirm that the statistical design limit in Appendix E of DPC-NE-2005P-A remains valid for the planned ABW LTA design.

As noted earlier, the ABW LTAs will be inserted into cores containing predominantly Westinghouse RFA fuel. Mixed core effects will be evaluated using the VIPRE-01 models described in DPC-NE-2004-PA and DPC-NE-2005P-A. The maximum allowable peaking limits for the ABW LTAs and the co-resident RFA fuel will conservatively reflect mixed core effects. The ABW LTAs have intermediate structural grids and mid-span mixing grids at essentially the same axial locations as the intermediate structural grids and flow mixing grids of the RFA fuel. Based on the hydraulic characteristics of the ABW LTAs and the co-resident Westinghouse RFA fuel, no mixed core penalty is anticipated for the RFA fuel. This expectation will be confirmed by the mixed core evaluation.

A3.4 UFSAR Chapter 15 Non-LOCA Transient and Accident Analyses

Duke will evaluate each of the Updated Final Safety Analysis Report (UFSAR) Chapter 15 non-LOCA accidents and transients for impacts from the ABW LTAs. The Duke safety analysis methodologies are described in four NRC-approved methodology reports: (i) DPC-NE-3000-PA, *Thermal-Hydraulic Transient Analysis Methodology* (Reference 20), (ii) DPC-NE-3001-PA, *Multidimensional Reactor Transients and Safety Analysis Physics Parameters Methodology* (Reference 21), (iii) DPC-NE-3002, *UFSAR Chapter 15 System Transient Analysis Methodology* (Reference 22), and (iv) DPC-NE-2009P-A, *Westinghouse Fuel Transition Report* (Reference

23). Duke will use its current approved methodology for the ABW LTA evaluations, with two exceptions: DNB analyses and gadolinia effects. Each is discussed below.

For those UFSAR Chapter 15 events involving the possibility of DNB, Duke will (i) evaluate the ABW LTAs against appropriate or conservative DNB limits, and (ii) ensure that the co-resident RFA assemblies are not adversely affected by the presence of the ABW LTAs. For DNB analyses of ABW fuel during design basis transients, Duke will use the VIPRE-01 code and models described in DPC-NE-3000-PA and DPC-NE-3001-PA, except that Duke will use the BWU-N and BWU-Z/MSM critical heat flux correlations to analyze the ABW LTAs in a mixed core configuration. As described in Section A3.3, the BWU-N correlation will be applied below the first mixing vane grid and the BWU-Z/MSM will be applied at all other elevations. These CHF correlations were developed by AREVA NP and have been reviewed and approved by the NRC (References 17 and 18), but are not yet reflected in the Duke DPC-NE-3000-P methodology report.

Duke has assessed the impact of fuel pellets containing gadolinia on non-LOCA safety analyses. The addition of gadolinia to fuel pellets has no significant adverse impact on transient DNB. Gadolinia does affect fuel pellet thermal conductivity and, therefore, centerline fuel temperatures. For gadolinia rods, Duke will use centerline fuel melt limits based on GDTACO that reflect the differences between uranium oxide fuel pellets and uranium oxide pellets containing gadolinia. Similarly, the impact of gadolinia on pellet thermal conductivity has the potential to affect fuel pellet energy deposition (i.e., cal/g) during a postulated rod ejection accident (UFSAR Section 15.4.8). For the ABW LTAs it will be verified that the maximum fuel pellet energy deposition in the pellets containing gadolinia remains below the regulatory limit during a postulated control rod ejection accident. Gadolinia integral absorber will impact the neutronic behavior of the fuel, so Duke will evaluate the impact of the inadvertent loading and operation of a fuel assembly in a improper position (UFSAR Section 15.4.7) using the methods and computer codes to calculate core power distributions described in Reference 10 (Revision 1 of DPC-NE-1005-P).

As noted above, mixed core effects will be specifically addressed in the UFSAR Chapter 15 non-LOCA safety analyses. The system analyses that are performed with the RETRAN code are based on full cores of RFA fuel, and those analyses are insensitive to the presence of a limited number of ABW LTAs. Core thermal-hydraulic (DNB) analyses of transients will explicitly consider mixed core effects.

A3.5 LOCA Analysis

The ABW LTAs will reside in a core of co-resident Westinghouse RFA fuel. A LOCA evaluation of the ABW LTAs will be performed in order to ensure compliance with 10 CFR 50.46 acceptance criteria. The evaluation will include consideration of the effects of thermal-mechanical and neutronic (gadolinia) design differences relative to the co-resident fuel assemblies. The evaluation will also include the capability of the fuel assembly to withstand the combined seismic and LOCA loads (coolable geometry criteria - grid crush evaluation). The long-term post-LOCA core cooling evaluation to demonstrate prevention of post-LOCA boric acid precipitation is unaffected by the design of the fuel assembly.

A small break LOCA is controlled by break size, available emergency core cooling system (ECCS) pumped and injected flows, and decay heat level. Small differences in fuel rod characteristics (i.e., geometry) will have little effect on the event. The principal concern is that of fuel rod heatup due to decay heat for those small breaks that culminate in core uncovery. The initial fuel stored energy is not a significant influence in a small break LOCA because the energy is quickly dissipated in the available coolant following the reactor trip. The ABW LTA fuel rods will be designed to operate at a power level below that of the highest power co-resident fuel. Therefore, the combination of factors described above will ensure that the ABW LTAs meet the 10 CFR 50.46 acceptance criteria for small break LOCA.

A4.0 Other Issues

A4.1 Dose Analysis

Fuel assembly design differences may result in minor changes to the conservatively-calculated radionuclide source term in the fuel rod. Those impacts can translate to minor changes in calculated control room and offsite doses following design basis accidents. Duke has performed a radioisotope source term calculation explicitly for the ABW design. Using this revised source term, Duke will evaluate the plant-specific doses from design basis accidents and verify that the doses are within regulatory limits.

A4.2 ABW LTA Design Evaluation

In Chapter 5 of the NRC-approved Advanced Mark-BW Fuel Assembly Mechanical Design Topical Report BAW-10239(P)-A (Reference 7), AREVA NP presented an example design evaluation to ensure that the ABW fuel assembly design meets the criteria for safe plant operation, including the expectations outlined in Section 4.2 of the NRC's Standard Review Plan (Reference 6). There are minor design differences between the ABW design evaluated for BAW-10239(P)-A and the design of the Catawba and McGuire ABW LTAs. The existing ABW analyses will be evaluated to ensure that they remain applicable to the Catawba and McGuire ABW LTAs. If necessary, the analyses will be revised to ensure that applicable limits are met.

A4.3 Impact on Co-Resident Fuel

Duke will perform an evaluation to verify that the ABW fuel assembly is compatible with the co-resident RFA fuel assemblies and all reactor internals and handling equipment.

A4.4 Nuclear Fuel Storage

Catawba Technical Specification 3.7.16 provides restrictions on fuel assembly characteristics that ensure that subcritical conditions are maintained in the spent fuel pool. Except for those uranium oxide fuel assemblies designated as "filler" assemblies for MOX fuel storage, Technical Specification 3.7.16 allows for unrestricted spent fuel pool storage of new or irradiated uranium oxide fuel assemblies having an initial enrichment up to 5.0 w/o uranium-235. Duke will perform criticality analyses using the currently-approved methodology (Reference 24) to ensure that the Technical Specification 3.7.16 limits remain valid for ABW fuel at Catawba.

McGuire Technical Specification 3.7.15 provides restrictions on fuel assembly characteristics that ensure that subcritical conditions are maintained in the spent fuel pool. At the present time Duke plans to store fresh and spent ABW LTAs in Region 1 of the spent fuel pool which allows for unrestricted storage of new or irradiated uranium oxide fuel assemblies having an initial enrichment up to 5.0 w/o uranium-235. Duke will perform criticality analyses using the currently-approved methodology (Reference 25) to ensure that the Technical Specification 3.7.15(a) limits remain valid for ABW fuel in Region 1 at McGuire.

A4.5 Emergency Core Cooling System Sump Screens

As part of the response to NRC Generic Letter 2004-02 related to potential debris blockage during emergency recirculation (Reference 26), Duke installed a modified containment sump strainer and supporting structure at Catawba Unit 2. Taking into account the modified containment sump strainer, a downstream effects evaluation has been performed which concluded that sufficient open flow paths would exist following an accident for cooling of the fuel (Reference 27). The same conclusion was reached for the modified containment sump strainer and supporting structure at McGuire Unit 2 (Reference 28). The downstream effects evaluation was reviewed and found to be acceptable for the ABW LTAs.

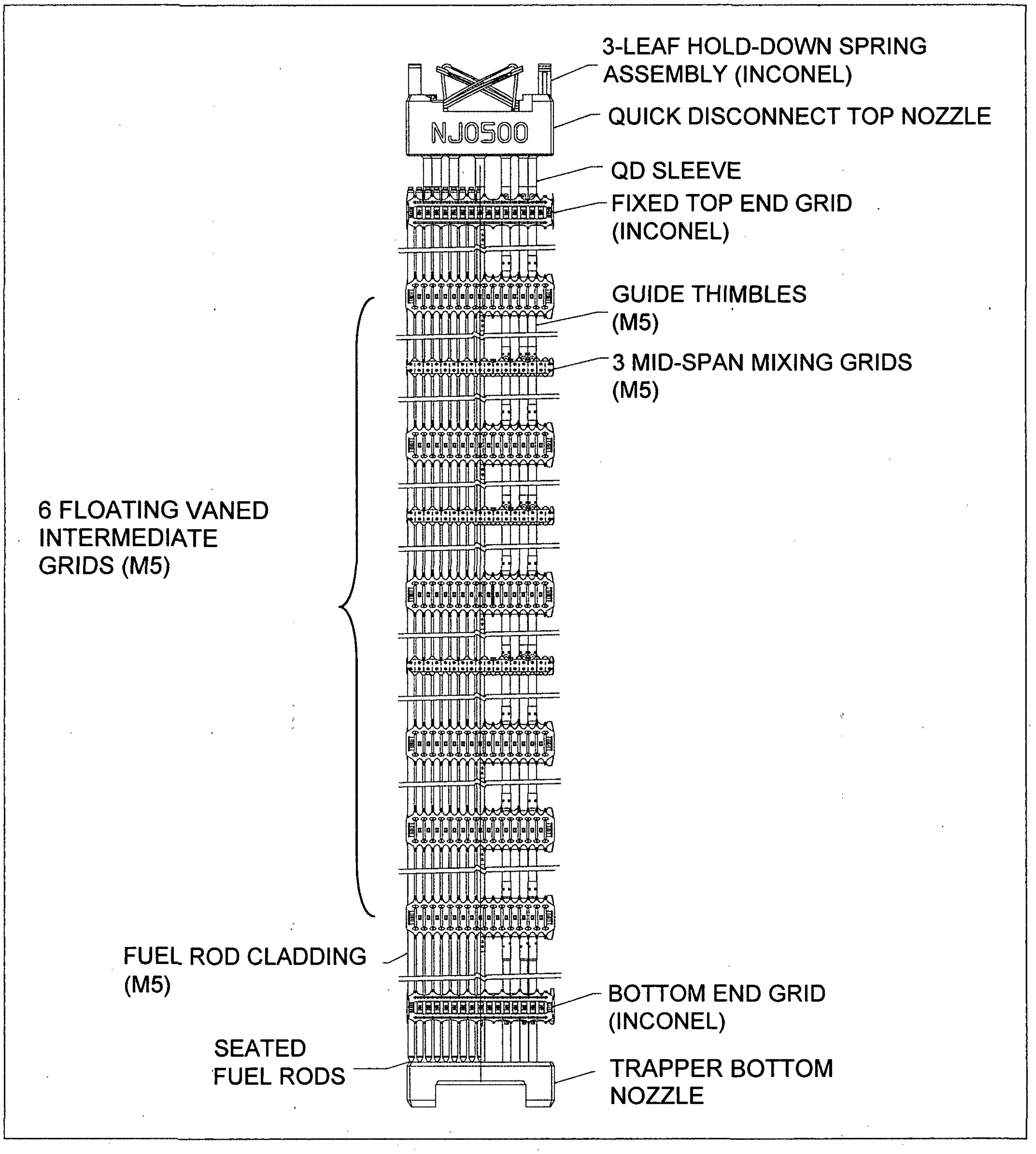
TABLE 1

Design Parameters for the ABW LTA and the Co-Resident RFA Fuel

Parameter	ABW LTA	RFA
Spacer grid envelope (in)	8.435	8.434
Fuel rod pitch (in)	0.496	0.496
Cladding material	M5™	ZIRLO™
Cladding OD (in)	0.374	0.374
Cladding thickness (in)	0.0225	0.0225
Fuel pellet diameter (in)	0.3225	0.3225
Column length (in)	144.0	144.0
Guide thimble material	M5™	ZIRLO™
Guide thimbles OD (in) (upper / lower)	0.482 / 0.429	0.482 / 0.439
Guide thimbles ID (in) (upper / lower)	0.450 / 0.397	0.442 / 0.397
Instrument guide thimble OD (in)	0.482	0.482
Instrument guide thimble ID (in)	0.450	0.442

FIGURE 1

AREVA NP Advanced Mark-BW Fuel Assembly



ATTACHMENT 2

List of Regulatory Commitments

1. Duke will modify Catawba UFSAR Section 4.2.1 once the amendment is approved. [cover letter]
2. Duke will implement the license amendments within 30 days of the NRC approval date. [cover letter]
3. The ABW LTAs will be placed in non-limiting core locations. [Enclosure 1, Attachment 1, Section A1.0]
4. Catawba 2, Cycle 17 will include no LTAs other than the ABW LTAs. [Enclosure 1, Attachment 1, Section A1.0]
5. McGuire 2, Cycle 20 will include no LTAs other than the ABW LTAs. [Enclosure 1, Attachment 1, Section A1.0]
6. For each affected reload, Duke will analyze the ABW LTAs as described in Enclosure 1, Attachment 1, Sections A3.0-A3.5 to ensure that the assemblies meet all applicable design and regulatory limits. [Enclosure 1, Attachment 1, Section A3.0]
7. Duke will limit gadolinia concentrations in ABW LTA fuel rods to 8 weight per cent or less. [Enclosure 1, Attachment 1, Section A3.2]
8. Duke will evaluate the plant-specific doses from design basis accidents with ABW LTAs and verify that the calculated doses are within regulatory limits. [Enclosure 1, Attachment 1, Section A4.1]
9. An evaluation of the existing ABW mechanical design analyses will be performed to ensure that those analyses remain applicable to the Catawba and McGuire ABW LTAs; if necessary, revisions to those analyses will be made to ensure that applicable limits are met. [Enclosure 1, Attachment 1, Section A4.2]
10. Duke will perform an evaluation to verify that the ABW fuel assembly is compatible with the co-resident RFA fuel assemblies and all reactor internals and handling equipment. [Enclosure 1, Attachment 1, Section A4.3]
11. Duke will perform criticality analyses to ensure that Catawba Technical Specification 3.7.16 (fuel storage) remains valid for ABW fuel. [Enclosure 1, Attachment 1, Section A4.4]
12. Duke will perform criticality analyses to ensure that McGuire Technical Specification 3.7.15(a) (fuel storage) remains valid for ABW fuel. [Enclosure 1, Attachment 1, Section A4.4]

ATTACHMENT 3

Catawba Technical Specification Page Markup

4.0 DESIGN FEATURES

4.1 Site Location

Catawba Nuclear Station is located in the north central portion of South Carolina approximately six miles north of Rock Hill and adjacent to Lake Wylie. The station center is located at latitude 35 degrees, 3 minutes, 5 seconds north and longitude 81 degrees, 4 minutes, 10 seconds west. The corresponding Universal Transverse Mercator Coordinates are E 493, 660 and N 3, 878, 558, zone 17.

4.2 Reactor Core

4.2.1 Fuel Assemblies

The reactor shall contain 193 fuel assemblies. Each assembly shall consist of a matrix of either ZIRLO™**, M5™,** or ~~**Zircalloy**~~**Zircaloy** fuel rods with an initial composition of natural or slightly enriched uranium dioxide (UO_2) as fuel material.* Limited substitutions of ZIRLO™, zirconium alloy, or stainless steel filler rods for fuel rods, in accordance with approved applications of fuel rod configurations, may be used. Fuel assemblies shall be limited to those fuel designs that have been analyzed with applicable NRC staff approved codes and methods and shown by tests or analyses to comply with all fuel safety design bases. A limited number of lead test assemblies that have not completed representative testing may be placed in nonlimiting core regions.

* A maximum of four lead assemblies containing mixed oxide fuel and M5™ cladding may be inserted into the Unit 1 or Unit 2 reactor core.

4.2.2 Control Rod Assemblies

The reactor core shall contain 53 control rod assemblies. The control material shall be silver indium cadmium and boron carbide as approved by the NRC.

4.3 Fuel Storage

4.3.1 Criticality

4.3.1.1 The spent fuel storage racks are designed and shall be maintained with:

(continued)

ATTACHMENT 4

Retyped Catawba Technical Specification Page

4.0 DESIGN FEATURES

4.1 Site Location

Catawba Nuclear Station is located in the north central portion of South Carolina approximately six miles north of Rock Hill and adjacent to Lake Wylie. The station center is located at latitude 35 degrees, 3 minutes, 5 seconds north and longitude 81 degrees, 4 minutes, 10 seconds west. The corresponding Universal Transverse Mercator Coordinates are E 493, 660 and N 3, 878, 558, zone 17.

4.2 Reactor Core

4.2.1 Fuel Assemblies

The reactor shall contain 193 fuel assemblies. Each assembly shall consist of a matrix of either ZIRLO™, M5™, or Zircaloy fuel rods with an initial composition of natural or slightly enriched uranium dioxide (UO_2) as fuel material.* Limited substitutions of ZIRLO™, zirconium alloy, or stainless steel filler rods for fuel rods, in accordance with approved applications of fuel rod configurations, may be used. Fuel assemblies shall be limited to those fuel designs that have been analyzed with applicable NRC staff approved codes and methods and shown by tests or analyses to comply with all fuel safety design bases. A limited number of lead test assemblies that have not completed representative testing may be placed in nonlimiting core regions.

* A maximum of four lead assemblies containing mixed oxide fuel and M5™ cladding may be inserted into the Unit 1 or Unit 2 reactor core.

4.2.2 Control Rod Assemblies

The reactor core shall contain 53 control rod assemblies. The control material shall be silver indium cadmium and boron carbide as approved by the NRC.

4.3 Fuel Storage

4.3.1 Criticality

4.3.1.1 The spent fuel storage racks are designed and shall be maintained with:

(continued)

ATTACHMENT 5

McGuire Technical Specification Page Markup

4.0 DESIGN FEATURES

4.1 Site Location

The McGuire Nuclear Station site is located at latitude 35 degrees, 25 minutes, 59 seconds north and longitude 80 degrees, 56 minutes, 55 seconds west. The Universal Transverse Mercator Grid Coordinates are E 504, 669, 256, and N 3, 920, 870, 471. The site is in northwestern Mecklenburg County, North Carolina, 17 miles north-northwest of Charlotte, North Carolina.

4.2 Reactor Core

4.2.1 Fuel Assemblies

The reactor shall contain 193 fuel assemblies. Each assembly shall consist of a matrix of either ZIRLO™, **M5™,** or ~~**Zircalloy**~~**Zircaloy** fuel rods with an initial composition of natural or slightly enriched uranium dioxide (UO_2) as fuel material. Limited substitutions of ZIRLO™, zirconium alloy or stainless steel filler rods for fuel rods, in accordance with approved applications of fuel rod configurations, may be used. Fuel assemblies shall be limited to those fuel designs that have been analyzed with applicable NRC staff approved codes and methods and shown by tests or analyses to comply with all fuel safety design bases. A limited number of lead test assemblies that have not completed representative testing may be placed in nonlimiting core regions.

4.2.2 Control Rod Assemblies

The reactor core shall contain 53 control rod assemblies. The control material shall be silver indium cadmium (Unit 1) silver indium cadmium and boron carbide (Unit 2) as approved by the NRC.

4.3 Fuel Storage

4.3.1 Criticality

4.3.1.1 The spent fuel storage racks are designed and shall be maintained with:

a. Fuel assemblies having a maximum nominal U-235 enrichment of 5.00 weight percent;

b. $k_{eff} < 1.0$ if fully flooded with unborated water, which includes an allowance for uncertainties as described in Section 9.1 of the UFSAR;

c. $k_{eff} \leq 0.95$ if fully flooded with water borated to 800 ppm, which includes an allowance for uncertainties as described in Section 9.1 of the UFSAR;

ATTACHMENT 6

Retyped McGuire Technical Specification Page

4.0 DESIGN FEATURES

4.1 Site Location

The McGuire Nuclear Station site is located at latitude 35 degrees, 25 minutes, 59 seconds north and longitude 80 degrees, 56 minutes, 55 seconds west. The Universal Transverse Mercator Grid Coordinates are E 504, 669, 256, and N 3, 920, 870, 471. The site is in northwestern Mecklenburg County, North Carolina, 17 miles north-northwest of Charlotte, North Carolina.

4.2 Reactor Core

4.2.1 Fuel Assemblies

The reactor shall contain 193 fuel assemblies. Each assembly shall consist of a matrix of either ZIRLO™, M5™, or Zircaloy fuel rods with an initial composition of natural or slightly enriched uranium dioxide (UO_2) as fuel material. Limited substitutions of ZIRLO™, zirconium alloy or stainless steel filler rods for fuel rods, in accordance with approved applications of fuel rod configurations, may be used. Fuel assemblies shall be limited to those fuel designs that have been analyzed with applicable NRC staff approved codes and methods and shown by tests or analyses to comply with all fuel safety design bases. A limited number of lead test assemblies that have not completed representative testing may be placed in nonlimiting core regions.

4.2.2 Control Rod Assemblies

The reactor core shall contain 53 control rod assemblies. The control material shall be silver indium cadmium (Unit 1) silver indium cadmium and boron carbide (Unit 2) as approved by the NRC.

4.3 Fuel Storage

4.3.1 Criticality

4.3.1.1 The spent fuel storage racks are designed and shall be maintained with:

a. Fuel assemblies having a maximum nominal U-235 enrichment of 5.00 weight percent;

b. $k_{eff} < 1.0$ if fully flooded with unborated water, which includes an allowance for uncertainties as described in Section 9.1 of the UFSAR;

c. $k_{eff} \leq 0.95$ if fully flooded with water borated to 800 ppm, which includes an allowance for uncertainties as described in Section 9.1 of the UFSAR;

ENCLOSURE 2

Request for Exemptions to Support the Use of M5™ Cladding

1. INTRODUCTION

2. REQUEST FOR EXEMPTIONS

    2.1 NRC Standard for Issuance of Exemptions under 10 CFR Part 50

    2.2 Regulatory Provisions from which Exemption Is Needed

    2.3 Circumstances Requiring an Exemption from the Fuel Cladding Assumptions in 10 CFR 50.46 and Appendix K to 10 CFR Part 50

    2.4 Exemption Required in Lieu of Complying with Cladding Requirements in 10 CFR 50.46 and Part 50, Appendix K as Written

    2.5. Basis and Justification for Granting Exemption

3. ENVIRONMENTAL CONSIDERATION

4. REFERENCES

1. INTRODUCTION

Duke Energy Corporation (Duke) hereby files this request for exemptions from portions of certain regulations contained in 10 CFR Part 50, in conjunction with the use of nuclear fuel rods clad with M5™ at certain of its nuclear generating facilities licensed by the U.S. Nuclear Regulatory Commission (NRC or Commission). This exemption request accompanies and is filed in conjunction with Duke's license amendment request whose focus is the upcoming use of nuclear fuel rods clad with M5™ at the Catawba Nuclear Station and the McGuire Nuclear Station. Duke plans to begin using AREVA NP Advanced Mark-BW (ABW) lead test assemblies (LTAs) into Catawba Unit 2 Cycle 17 in the Spring of 2009, followed by batch implementation of ABW fuel beginning in late 2012. Duke also plans to begin using ABW LTAs in McGuire Unit 2 Cycle 20 in the Fall of 2009, followed by batch implementation of ABW fuel beginning in early 2013. Each element of the Commission's standards for the issuance of exemptions, set forth in 10 CFR 50.12, is discussed below and a demonstration provided that such standard is met.

These exemptions are necessitated by the wording of the regulations in 10 CFR Part 50. In two instances, NRC regulations assume the use of fuel rods clad with either Zircaloy or ZIRLO™. In each of these situations, an exemption is required from certain provisions in 10 CFR Part 50; namely, portions of 10 CFR 50.46 and Appendix K to 10 CFR Part 50.

This request addresses individually each exemption sought. The discussion of each proposed exemption cites the applicable NRC standard for issuance of an exemption from the affected part of the regulations, identifies the specific regulations (or portions thereof) for which an exemption is being sought, and provides detail concerning the extent of the proposed exemptions. A justification for each exemption request is also provided, along with a demonstration that the criteria for issuance of an exemption are met and that the Commission's underlying reason for promulgation of the regulation is satisfied.

Duke previously applied for and received an exemption from the same requirements in connection with the use of four mixed oxide (MOX) fuel lead assemblies clad with M5™ at the Catawba Nuclear Station. Section 2 of this exemption request for Catawba and McGuire is based on (i) the previously-approved exemption request for the MOX fuel lead assemblies (Attachment 6 of Reference 1) and (ii) the response to a request for information related to that exemption request (Reference 2, response to Question 47).

2. REQUEST FOR EXEMPTION

Duke requests an exemption from the requirements of 10 CFR 50.46(a)(1) and 10 CFR Part 50 Appendix K such that explicit consideration of the M5™ cladding planned for use with ABW fuel assemblies is not required in order to be in compliance with these regulations.

2.1. NRC Standard for Issuance of Exemptions under 10 CFR Part 50

10 CFR 50.12(a)(1)-(2) provides that upon application by any interested person, the NRC may grant an exemption from the requirements in NRC regulations found in Part 50 if the exemption is authorized by law, if granting the exemption will not present "an undue risk to the public health and safety" and is "consistent with the common defense and security", and if "special circumstances" are shown to be present. Special circumstances are present, for example, when application of the regulation in the particular circumstances would not serve the underlying purpose of the rule or is not necessary to achieve the underlying purpose of the rule [see 10 CFR 50.12(a)(2)(ii)]. All of these criteria are met with respect to the exemption request described below.

2.2 Regulatory Provisions from which Exemption Is Needed

10 CFR 50.46(a)(1) *Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors* requires each boiling water reactor and pressurized water reactor "fueled with uranium oxide pellets within cylindrical zircaloy or ZIRLO cladding" to be provided with an emergency core cooling system (ECCS) designed so that its calculated cooling performance following a postulated Loss of Coolant Accident (LOCA) meets certain criteria in Section 50.46(b). ECCS cooling performance must be calculated in accordance with "an acceptable evaluation model", for a number of postulated LOCAs. The evaluation model must include sufficient justification to show that the analytical technique realistically describes the behavior of the reactor system during a LOCA. Alternatively, an ECCS evaluation model may be developed in conformance with "the required and acceptable features" of the ECCS evaluation models set forth in Appendix K to 10 CFR Part 50 [see Section 50.46(a)(1)(i)].

Consistent with Section 50.46, Appendix K to 10 CFR Part 50 *ECCS Evaluation Models* also reflects certain assumptions regarding the use of fuel cladding that is either Zircaloy or ZIRLO™.

2.3 Circumstances Requiring an Exemption from the Fuel Cladding Assumptions in 10 CFR 50.46 and Appendix K to 10 CFR Part 50

Duke plans to utilize nuclear fuel rods clad with M5™ at McGuire and Catawba, beginning with a Lead Test Assembly (LTA) program for AREVA NP ABW fuel at Catawba Unit 2 in the Spring of 2009, continuing with ABW LTAs at McGuire Unit 2 in the Fall of 2009, and eventually leading to batch use of ABW fuel beginning in 2012. The planned use of ABW fuel requires that Duke obtain from the NRC an exemption from the assumption (and, thus, the implicit requirement) in Section 50.46 and Appendix K to 10 CFR Part 50 that Zircaloy or ZIRLO™ fuel cladding will be used in every commercial nuclear reactor. M5™ is an advanced cladding which has a number of properties that enhance cladding performance. The chemical composition of M5™ cladding differs somewhat from that of both Zircaloy and ZIRLO™. Because the use of M5™ cladding is not consistent with 10 CFR 50.46 and 10 CFR Part 50 Appendix K as written, Duke is requesting an exemption from these fuel cladding requirements.

2.4 Exemption Required in Lieu of Complying with Cladding Requirements in 10 CFR 50.46 and Part 50, Appendix K as Written

Duke requests an exemption from the requirements of Section 50.46 and Appendix K to 10 CFR Part 50, as those requirements relate to the cladding of nuclear fuel to be used at the McGuire or Catawba facilities. This exemption is requested to specifically permit the use of the AREVA NP M5™ advanced alloy as an acceptable fuel cladding material for fuel assemblies to be used at these facilities.

2.5. Basis and Justification for Granting Exemption

As shown below, the requirements of 10 CFR 50.12 for the issuance of an NRC exemption have been satisfied.

1. <u>This exemption request is authorized by law</u>

As required by 10 CFR 50.12(a)(1), this requested exemption is "authorized by law". The selection of a specific cladding material in 10 CFR 50.46, and implied in Appendix K to 10 CFR Part 50, was adopted at the discretion of the Commission consistent with its statutory authority. No statute required the NRC to adopt this specification. Additionally, the NRC has the authority under Section 50.12 to grant exemptions from the requirements of Part 50 upon a showing of proper justification by the applicant. Further, it should be noted that, by submitting this exemption request, Duke does not seek an exemption from the acceptance and analytical criteria of 10 CFR 50.46 and Appendix K to 10 CFR Part 50. The intent of the request is solely to allow the use of existing criteria set forth in these regulations for application to the M5™ cladding material.

2. <u>Granting this exemption request will not present an undue risk to public health and safety</u>

As demonstrated below, the acceptance criteria of 10 CFR 50.46 are applicable to M5™ cladding. In addition, the Baker-Just equation, required by Appendix K to 10 CFR Part 50 to be used to predict the cladding oxidation rate, is also shown to conservatively predict the oxidation rate for M5™ cladding. The impact of M5™ cladding on LOCA analysis was specifically evaluated in AREVA NP topical report BAW-10227P-A (Reference 3). This report demonstrated and NRC accepted (Reference 4) that the acceptance criteria in 10 CFR 50.46 and

10 CFR 50 Appendix K are valid for M5™ cladding.

ABW LTAs clad with M5™ will be placed in non-limiting core locations and evaluated to ensure that applicable ECCS-related criteria are met. For batch quantities of fuel clad with M5™, Technical Specification 5.6.5 requires the use of NRC-approved analytical methods to establish core operating limits that ensure that all applicable criteria (including those related to the ECCS) are met. Because the 10 CFR 50.46 and Appendix K acceptance criteria have been shown to be appropriate for M5™ cladding, the application of NRC-approved analytical methods per Technical Specification 5.6.5 provides reasonable assurance that the ECCS will function to protect public health and safety in the event of a LOCA. Thus, the granting of this exemption request will not pose an undue risk to public health and safety.

3. Granting this exemption request is consistent with common defense and security

This exemption request is only to allow the application of the aforementioned regulations to a different, more advanced, cladding material. The existing requirements and acceptance criteria currently found in the affected regulations will be maintained if the exemption is granted. Accordingly, the granting of this exemption request is consistent with the common defense and security.

4. Special circumstances support the issuance of an exemption

10 CFR 50.12(a)(2) allows the NRC to grant an exemption to the regulations when special circumstances are present. As discussed below, the special circumstances described in 10 CFR 50.12(a)(2)(ii) support the granting of this exemption application, in that application of these regulations in the particular circumstances described is not necessary to achieve the underlying purpose of the affected regulations; in this case, 10 CFR 50.46, and Appendix K to 10 CFR Part 50.

The underlying purpose of 10 CFR 50.46 is to ensure that light water reactors have an adequate ECCS to mitigate a postulated LOCA. To assess the adequacy of the ECCS design, 10 CFR 50.46(b) establishes five acceptance criteria: peak cladding temperature less than 2200°F, local cladding oxidation less than 17%, core-wide cladding oxidation less than 1%, coolable core geometry, and provisions for effective long-term cooling.

With regard to the exemption request for M5™ cladding use, paragraph I.A.5 of Appendix K requires that the Baker-Just equation be used in the ECCS evaluation model to determine the rate of energy release, cladding oxidation, and hydrogen generation from metal-water reaction during a LOCA. The Baker-Just equation is known to provide a conservative representation of Zircaloy cladding oxidation. To verify that the Baker-Just equation is similarly appropriate for application to M5™ cladding, AREVA NP conducted high temperature oxidation tests. At high temperatures the oxidation rates for M5™ alloy and Zircaloy-4 are essentially the same. At lower temperatures, the M5™ oxidation (corrosion) rate is substantially lower than Zircaloy-4. For both cladding materials, the Baker-Just equation conservatively bounds the data. This information is documented in Reference 3. Therefore, the required cladding oxidation model (Baker-Just equation) is appropriate for application to M5™ advanced alloy cladding material, and any implied restriction on cladding material related to the metal-water reaction portion of 10 CFR 50 Appendix K is not necessary to achieve the underlying purpose of 10 CFR 50.46.

The strict application of the existing fuel cladding requirement in the particular circumstances represented by this exemption application would not serve the underlying purpose of the rule, which is to ensure that light water reactors have adequate acceptance criteria for their ECCS to assure adequate core cooling in the event of a design basis LOCA. In addition, as shown above, the strict application of the existing fuel cladding requirement is not necessary to achieve the underlying purpose of the rule. In Reference 3 AREVA NP demonstrated that the ECCS acceptance criteria applied to reactors with Zircaloy clad fuel rods are also applicable to reactors with M5™ clad fuel rods. This report also showed that the M5™ cladding was capable of satisfying these design and acceptance criteria. Therefore, the underlying purposes of 10 CFR 50 Appendix K, paragraph I.A.5, are achieved through the use of M5™ as a fuel rod cladding material.

5. Relevant Precedent Also Supports Issuance of the Requested Exemption

As further support for this requested exemption, Duke notes that relevant precedent exists for granting an exemption from the fuel cladding requirements in 10 CFR 50.46 and 10 CFR 50 Appendix K, in connection with the anticipated use of fuel rods clad with M5™ at McGuire and Catawba. On numerous instances, summarized in the following table, the NRC has issued similar exemptions to United States licensees, including the Oconee Nuclear Station (which is owned and operated by Duke) and the Duke-operated Catawba Nuclear Station (solely for the purpose of the MOX fuel lead assembly program).

Reactor	**NSSS Design**	**Fuel Design**	**Exemption Date**
Oconee Units 1, 2, and 3	Babcock & Wilcox	15x15	March 23, 2000
Sequoyah Units 1 and 2	Four loop Westinghouse	17x17	July 29, 2000
Davis Besse Unit 1	Babcock & Wilcox	15x15	March 15, 2000
Three Mile Island Unit 1	Babcock & Wilcox	15x15	May 8, 2001
Calvert Cliffs Unit 2*	Combustion Engineering	14x14	April 11, 2003
North Anna Units 1 and 2	Three loop Westinghouse	17x17	September 23, 2003
Crystal River Unit 3	Babcock & Wilcox	15x15	September 26, 2003
Catawba Units 1 and 2*	Four loop Westinghouse	17x17	March 3, 2005
Arkansas Nuclear One Unit 1	Babcock & Wilcox	15x15	July 25, 2005
Ft. Calhoun Unit 1	Combustion Engineering	14x14	August 17, 2006
Braidwood Units 1 and 2*	Four loop Westinghouse	17x17	September 27, 2007

* LTAs only

3. ENVIRONMENTAL CONSIDERATION

The issuance of the requested exemption should have no significant impact on the environment, as discussed below.

Identification of the Proposed Action

The proposed action would grant the Catawba and McGuire Nuclear Stations exemptions from portions of 10 CFR 50.46 and Appendix K to 10 CFR Part 50. Those portions of the regulations assume the use of fuel rods clad with either Zircaloy or ZIRLO™. The exemptions would therefore allow the use M5™, an advanced alloy fuel cladding material for pressurized-water reactors, in nuclear fuel at the Catawba and McGuire Nuclear Stations.

The Need for the Proposed Action

The proposed action is needed so that Duke Energy Carolinas, LLC (Duke) can use M5™, an advanced alloy for fuel rod cladding and other assembly structural components, at the Catawba and McGuire Nuclear Stations. Section 50.46 and Part 50 of 10 CFR, Appendix K, make no provisions for use of fuel rods clad in a material other than Zircaloy or ZIRLO™. Because the chemical composition of the M5™ alloy differs from the specifications for Zircaloy or ZIRLO™, a plant-specific exemption is required to allow the use of the M5 alloy as a cladding material at the Catawba and McGuire Nuclear Stations.

Environmental Impacts of the Proposed Action

The underlying purposes of 10 CFR 50.46 and 10 CFR Part 50, Appendix K, are to ensure that facilities have adequate acceptance criteria for the emergency core cooling system (ECCS), and to ensure that cladding oxidation and hydrogen generation are appropriately limited during a loss-of-coolant accident (LOCA) and conservatively accounted for in the ECCS evaluation model, respectively. Neither 10 CFR 50.46 nor 10 CFR Part 50, Appendix K, explicitly allows the use of M5™ as a fuel rod cladding material. Topical Report (TR) BAW-10227P, Revision 1, "Evaluation of Advanced Cladding and Structural Material (M5) in PWR Reactor Fuel", which was approved by the NRC in June 2003, demonstrated that the effectiveness of the ECCS will not be affected by a change from Zircaloy to M5™. In addition, TR BAW-10227P demonstrated that the Baker-Just equation (used in the ECCS evaluation model to determine the rate of energy release, cladding oxidation, and hydrogen generation) is conservative in all post-LOCA scenarios with respect to M5™ advanced alloy as a fuel rod cladding material or in other assembly structural components.

This requested exemption, if granted, would result in the same ECCS acceptance criteria being in effect for M5™ fuel rod cladding as are currently in effect for Zircaloy or ZIRLO™ fuel rod cladding. As discussed in Section 2.5 of this enclosure, those criteria are appropriate for M5™ and are adequate to protect the health and safety of the public. Therefore, the proposed action will not significantly increase the probability or consequences of accidents. No changes are being made in the types of effluents that may be released off site. The application of the ECCS acceptance criteria to fuel clad with M5™ does not significantly increase either the amount of any effluent released off site or occupational or public radiation exposure. Therefore, there are no significant radiological environmental impacts associated with the proposed action.

With regard to potential non-radiological impacts, the proposed action does not have a potential to affect any historic sites. It does not affect non-radiological plant effluents and has no other environmental impact. Therefore, there are no significant non-radiological environmental impacts associated with the proposed action.

Accordingly, it may be concluded that there are no significant environmental impacts associated with the proposed action.

Environmental Impacts of the Alternatives to the Proposed Action

The alternative to the proposed action is the denial of the exemption request (i.e., the "no-action" alternative). Denial of the application would result in no change in current environmental impacts. The environmental impacts of the proposed action and the alternative action are similar.

Alternative Use of Resources

The action does not involve the use of any different resource than those previously considered in NUREG-0063, "Final Environmental Statement Related to the Operation of William B. McGuire Nuclear Station, Units 1 and 2," dated April 1976; in the Addendum to NUREG-0063 issued in January 1981; and in NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 8, Regarding McGuire Nuclear Station, Units 1 and 2, Final Report," dated December 2002.

The action does not involve the use of any different resource than those previously considered in NUREG-0921, "Final Environmental Impact Statement Related to the Operation of Catawba Nuclear Station, Units 1 and 2," dated January 1983; and in NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 9, Regarding Catawba Nuclear Station, Units 1 and 2, Final Report," dated December 2002.

4. REFERENCES

1. Letter, M. S. Tuckman (Duke) to U. S. Nuclear Regulatory Commission, Proposed Amendments to the Facility Operating License and Technical Specifications to Allow Insertion of Mixed Oxide (MOX) Fuel Lead Assemblies and Request for Exemption from Certain Regulations in 10 CFR Part 50, February 27, 2003.
2. Letter, H. B. Barron (Duke) to U. S. Nuclear Regulatory Commission, Response to Request for Additional Information Regarding the Use of Mixed Oxide Lead Fuel Assemblies, November 3, 2003.
3. BAW-10227P-A, Revision 1, *Evaluation of Advanced Cladding and Structural Material (M5™) in PWR Reactor Fuel*, AREVA NP, June 2003.
4. Letter, S. A. Richards (NRC) to T. A. Coleman (Framatome Cogema Fuels), Revised Safety Evaluation (SE) for Topical Report BAW-10227P: "Evaluation of Advanced Cladding and Structural Material (M5) in PWR Reactor Fuel," February 4, 2000.