SUNSI Review Complete
Template = ADM-013
E-RIDS=ADM-03
ADD=Shirley Rohren

COMMENT (1)
PUBLICATION DATE:
1/8/2019
CITATION 84 FR 88

PUBLIC SUBMISSION

As of: 3/19/19 2:41 PM
Received: February 07, 2019
Status: Pending_Post
Tracking No. 1k3-984e-8xgz
Comments Due: February 07, 2019
Submission Type: Web

Docket: NRC-2018-0277
Applications and Amendments to Facility Operating Licenses and Combined Licenses Involving Proposed No Significant Hazards Considerations and Containing Sensitive Unclassified Non-Safeguards Information and Order Imposing Procedures for Access to Sensitive Unclassified Non-Safeguards Information

Comment On: NRC-2018-0277-0001
Applications and Amendments to Facility Operating Licenses and Combined Licenses Involving Proposed No Significant Hazards Considerations and Containing Sensitive Unclassified Non-Safeguards Information and Order Imposing Procedures for Access to Sensitive Unclassified Non-Safeguards Information

Document: NRC-2018-0277-DRAFT-0002
Comment on FR Doc # N/A

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General Comment

See attached file(s)

Attachments

TVEL-comments

Docket ID NRC–2018–0277

Braidwood Station (Braidwood), Docket Nos. STN 50-456 and STN 50-457

Comments Regarding Proposed License Amendment to authorize the use of up to eight Joint Stock Company ''TVEL'' (Fuel Company of Rosatom) TVS–K lead test assemblies (LTAs) in non-limiting reactor core locations for operation and evaluation

Submitted by Ralph Caruso and Samuel Miranda, PE

February 6, 2019

The following comments pertain to the Braidwood license amendment request (LAR) dated July 19, 2018, as supplemented by letter dated October 19, 2018. Publicly-available versions are in ML18204A169 and ML18296A288, respectively. The proposed amendment would authorize the use of up to eight Joint Stock Company ''TVEL'' (Fuel Company of Rosatom) TVS–K lead test assemblies (LTAs) in non-limiting reactor core locations for operation and evaluation. The proposed amendment was noticed in the Federal Register on January 8, 2019 (84 FR 91).

Introduction

By Federal Register notice (FRN) dated June 7, 2018 (83 FR 26503), as supplemented by FRN dated July 2, 2018 (83 FR 30989), the NRC solicited public comments on a draft letter to the Nuclear Energy Institute (NEI) "clarifying the regulatory paths for the use of lead test assemblies (LTAs)" (ML18100A045).

A former NRC staff member (Mr. Rick Ennis) previously raised a number of concerns on the proposed regulatory framework regarding use of LTAs. These concerns were summarized in an internal NRC memo to the NRC's General Counsel, dated March 22, 2018, which was co-authored with Mr. Chernoff (ML18078A010). The March 22, 2018, memo raised concerns regarding an earlier version of the draft letter to NEI. Following the retirement of Mr. Ennis from the NRC in the spring of 2018, Mr. Chernoff filed a non-concurrence on the current version of the NEI letter (ML18151B016).

The NRC has not yet resolved the comments received on the regulatory framework described in the draft memo to NEI. As such, final guidance regarding the use of LTAs has not been issued.

Mr. Ennis also filed a set of comments (ML 18333A046) concerning the use of a limited number of Accident Tolerant Fuel (ATF) Lead Test Rods (LTRs) in two Lead Test Assemblies (LTAs) during Byron Unit 2, Cycles 22, 23, and 24. The proposed amendment was noticed in the Federal Register on November 6, 2018 (83 FR 55573).

Mr. Caruso and Mr. Miranda are retired NRC employees, who collectively represent more than eight decades of experience in the nuclear industry.

Mr. Caruso was the Chief of the NRC's BWR and Nuclear Performance Section, Reactor Systems Branch, NRR, from 1997 to 2003, and was Group Leader of the Analytical Support Group of the Division of Systems Safety and Analysis in NRR from 1992 to 1997. As the Chief of the BWR and Nuclear Performance Section, he oversaw the review and approval of all new commercial fuel designs in the

United States, and the authorization for the use of Lead Test Assemblies in licensed commercial reactors, and the review and approval of technical report WCAP-15604-NP Revision 2-A "Limited Scope High Burnup Lead Test Assemblies", September 2003

Mr. Miranda worked at Westinghouse Electric from 1970 until 1994, and at the NRC until 2014. At Westinghouse, he led an international team of engineers to design the automatic reactor protection system, and to perform the supporting accident analyses required to complete the design and construction of the Temelin units (two Soviet-designed, VVER-1000 type PWRs in the Czech Republic, near České Budějovice). This included the modeling and analyses of Westinghouse-supplied hexagonal fuel assemblies. He also managed a multi-million dollar joint research program with Électricité de France, Framatome, and Commissariat à L'Énergie Atomique to trace the flow, inside reactor cores that would be caused by asymmetric cooling accidents. At the NRC, he reviewed LARs involving proposed power upratings, license renewals, and modifications of automatic reactor protection systems.

Discussion

We have recently become aware of activities by the NRC staff to clarify staff policies concerning the use of Lead test Assemblies in operating reactors, and to streamline the process for approving their use. This matter has a very long history. The fuel vendors have continually improved their products, by changes to the mechanical designs, the fuel pellet characteristics, and thru the invention of new cladding materials to replace zirconium alloys that were originally developed over 50 years ago.

We believe that it is important to test these new fuel designs and materials under conditions that are representative of the conditions that they will see in commercial use. This is difficult, however, because there are very few fuel test reactors, few hot cell inspection facilities, and the transportation of irradiated fuel is complicated and expensive. But proposed new reactor designs cannot proceed without this testing, so the use of existing commercial reactors for test irradiation is the only option.

Testing of new fuel designs is not without risk, and the insertion of LTAs into commercial reactors needs to be done carefully. In 2003 the staff issued guidelines for the use of LTAs to support extensions of fuel rod burnup limits. Topical Report WCAP-15604-NP, Rev 2 was the result. The staff engaged in public meetings and exchanged correspondence with representatives of the industry, in order to develop a set of guidelines that would provide a structured process for regulating LTAs while maintaining safety. It was hoped that these guidelines would help ensure uniformity in data collection, make evaluation of new material properties or limits more predictable, and ensure a structured process for data feedback to the NRC staff. The guidelines were developed to be consistent with the NRC's performance goals of maintaining safety, increasing public confidence, improving regulatory efficiency, and reducing regulatory burden.

The authors of the latest draft guidance letter seem to be unaware of the existence of this topical report. It is not referenced in any of the different versions of the guidance letter, or in staff presentations, or in any licensee correspondence or staff safety evaluations. WCAP-15604 was focused on testing to extend fuel burnup limits, but it can serve as the base for new guidance related to the use of new cladding materials.

The proposed license amendment for Braidwood does not follow the guidance in WCAP-15604, and is not consistent with previous interpretations of the process for review and approval of LTA campaigns.

The use of a new cladding material without formal staff review is a serious departure from past practices. The characterization of E110opt in the LAR as "chemically similar to M5" is disingenuous. It is NOT the same as M5, even though the chemical composition is the same. Only a basic knowledge of chemistry is needed to recognize this misleading statement. Our knowledge of the behavior of E110 (the precursor to E110opt) is that it does not behave the same as M5, and we have seen proprietary explanations of this difference that do not relate to chemical composition. If E110opt is indeed "the same as M5", then this should be documented in test reports that have been reviewed by the NRC staff.

This application is a good example of the sort of problems that will arise if the staff allows the introduction of LTAs that use significantly different designs and new materials that have not been previously reviewed. The LAR is vague about the specific data and analyses that are supposed to be used to justify the safety of these new designs, but many of the important analyses have not been done;

other analyses are promised to be done at some time in the future, and "data" generated by computer codes will be authorized to stand in place of actual measured data from experimental test facilities. These practices do not constitute "good engineering judgment".

The evidence to show that the TVEL's quality assurance program complies with the requirements of Appendix B, including all suppliers for material, equipment, and parts is very thin. The LAR states that the tests and analyses that have been performed by TVEL "by qualified personnel", without any clear statement that they been done in accordance with all of the requirements of Appendix B. What "recognizable standards" were used? The document states that the "Testing output has been documented and the configuration is controlled", but it is far from clear that these reports been submitted and reviewed by the NRC for compliance with Appendix B.

In fact, it appears that the staff is not completely satisfied with these commitments, because it has scheduled an "audit [of] the evaluations and analyses performed to support loading of the TVSK LTAs at Braidwood Station, to identify appropriate additional information to request for submittal. Such information would be that required to determine (1) whether the proposed combinations of methodologies are appropriate for their intended implementation, and (2) whether reasonable assurance exists that Braidwood Station can operate safely with the TVS-K LTAs loaded as specified." (ML19031C845) This audit will be performed during the week of February 11, 2019, after the comment period for this LAR has closed. It therefore seems to be premature for the staff to publish this 50.92 determination before the audit has been complete and documented.

If the NRC wants to make it easier for the developers of new nuclear fuel to develop better fuel designs, it MUST ensure that the design, construction, and testing of those new fuel designs complies with the NRC's quality assurance requirements. The nuclear industry does not need any discovery, late in a very expensive program, that corners have been cut in design, manufacture, or testing.

We completely endorse the positions stated by Mr. Ennis in his non-concurrence memorandum of March 22, 2018, and the comments he provided regarding the use of a limited number of Accident Tolerant Fuel (ATF) Lead Test Rods (LTRs) in two Lead Test Assemblies (LTAs) during Byron Unit 2, Cycles 22, 23, and 24. We request that the staff consider each of Mr. Ennis' comments again, in the context of this LAR, and provide a detailed technical and regulatory response that is coherent and consistent.

We also believe that it would be wise to consider them in the context of the Byron LTA proposal, which we understand has been re-noticed for public comment. Instead of reducing uncertainty in the industry about LTA programs, and increasing public confidence, we believe that the staff is creating chaos and fear. Those of us who have actual experience in this matter are not comfortable with the proposed policies and actions.

Discussion of Specified Considerations

The LAR, if granted, will allow Exelon (EGC) to load up to eight TVS–K lead test assemblies (LTAs), fabricated by Joint Stock Company ''TVEL'' (Fuel Company of Rosatom), into non-limiting reactor core locations, of its Braidwood Stations, for operation and evaluation. EGC has supplied a 10 CFR 50.91(a) "no significant hazards consideration", on pages 91 and 92 of the aforementioned Federal Register notice, to support its LAR.

The Braidwood Stations are two Westinghouse pressurized water reactors (PWRs). Unit #1 came online in July 1987, and Unit #2 came online in May 1988. The NRC licensed them, under 10 CFR 50, to operate until 2026 and 2027, respectively, and then re-licensed them, under 10 CFR 54, to extend operations until 2046 and 2047. Approval of EGC's LAR will allow EGC to demonstrate the performance of TVEL's TVS-K LTAs, and mixed fuel cores, in preparation for a potential transition from Westinghouse fuel assemblies to TVEL's TVS-K fuel assemblies. This would be the first use of the TVS-K design in the U.S.

The following comments and questions organized according to three categories.

(A.) 10 CFR 50.91(a), "No Significant Hazards Consideration"

(B.) Design and Operations Considerations

(C.) Trade Considerations

(A.) 10 CFR 50.91(a), "No Significant Hazards Consideration"

10 CFR 50.91(a) asks the licensee three questions. The licensee responds to each question with a "no". The NRC then relies upon the licensee's responses to conclude that the LAR will not pose any significant hazards. Our comments are presented below:

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

Response: "No. The proposed change involves only a small number of LTAs, which will be designed to be compatible from a neutronic, thermalhydraulic, and mechanical standpoint with all plant Systems, Structures, and Components (SSCs). The fuel pellets and fuel rods themselves will have no impact on accident initiators or precursors."

(A.1) ML18204A169 states, "The evaluation is expected to conclude that the 10 CFR 50.46 reported peak clad temperature remains unchanged due to the negligible change in assembly coolant flow resulting from the insertion of TVS-K LTAs." ML18204A169 also states that the outside diameter of a TVS-K LTA fuel rod is 0.374 inches, which is larger than the existing Westinghouse VANTAGE+ fuel rod diameter of 3.60 inches. This will reduce the flow area of a TVS-K LTA assembly, of 264 rods, by almost 8%. Explain how this would result in a "negligible change in assembly coolant flow".

Response: “There will not be a significant impact on the operation of any plant SSC or on the progression of any operational transient or design basis accident.”

(A.2) The reduced flow area of a TVS-K LTA assembly would have the effect of partially blocking flow through the eight TVS-K LTA assemblies. This would skew the overall distribution of coolant flow through the core that could alter the redial power distribution, change fuel peaking factors, and ultimately reduce core thermal margin. Explain how this would “not be a significant impact on the … progression of any operational transient or design basis accident.”

Response: “Based on the above discussion, the proposed changes do not involve a significant increase in the probability or consequences of an accident previously evaluated.”

(A.3) ML18204A169 states, “Although, the use of TVS-K LTAs is a "first of a kind" LTA initiative in the U.S., prior test experience with the TVS-K LTAs in the Ringhals 3 core provides high confidence that the inclusion of up to eight TVS-K LTAs in a mixed fuel core will not impact the public health and safety; and that there will not be a significant impact on any aspect of normal plant operations or accident analyses.” The Braidwood Stations are Westinghouse four-loop PWRs, each of which is licensed according to US regulations. Ringhals 3 is a Westinghouse three-loop plant, which is licensed according to Swedish regulations. The coolant flow through the reactor vessel of a four-loop plant (Braidwood) is different from the coolant flow through the reactor vessel of a three-loop plant (Ringhals). The difference is most pronounced during asymmetric cooling accidents (e.g., steam line breaks). Relatively cold water, entering the core, through a reactor vessel inlet nozzle that is connected to the affected steam generator will not mix uniformly with the relatively hot water that enters through the other inlet nozzles. Fuel assemblies that are located around the core periphery (e.g., in nonlimiting locations); and near the relatively cold inlet nozzle, will experience a greater increase in reactivity than other fuel assemblies. In the event of a post-trip return to criticality, these fuel rods could fail, if they’re loaded into locations that are near a control or shutdown rod that has not been inserted into the core. Please explain how this would not be a “significant increase in the … consequences of an accident previously evaluated.”

(A.4) Mixing in the core of a three-loop plant is generally better than mixing in the core of a four-loop plant. That is, a relatively cold third of the inlet flow mixes more uniformly than does a relatively cold fourth of the inlet flow. Mixing factors are determined by scale-model tests, and input into approved, plant simulation codes. Westinghouse’s mixing factors were derived from the results of flow traces inside a tenth-scale, Plexiglas model, and in a fifth-scale, steel model of selected Westinghouse reactor vessel designs. These tests were performed in Paris, and Cadarache, respectively, by Électricité de France, and France’s Commissariat à L'Énergie Atomique, which participated, along with Westinghouse and Framatome, in a multi-million dollar joint research program. The results verified the results of earlier tests, which were performed by Westinghouse, in a seventh-scale model of the Indian Point reactor vessel. Mixing data are expensive, proprietary information that is closely held by Westinghouse, Framatome, Électricité de France, and the Commissariat à L'Énergie Atomique. Does TVEL have access to this information, or an equivalent that is applicable to Westinghouse reactor vessel dimensions and geometries?

(A.5) ML18204A169 states, “Due to the similarities between the TVS-K fuel and the resident Westinghouse fuel, the placement of a limited number of TVS-K LTAs in nonlimiting core locations is not

expected to impact normal plant operations or accident analysis results." How will the larger fuel rod OD affect normal plant operations or accident analysis results?

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

Response: No. "The use of TVS–K LTAs does not involve any alteration to plant equipment or procedures that would introduce any new or unique operational modes or accident precursors."

(A.6) Identify and describe TVEL's standards for fuel performance under normal, transients and accident conditions.

(A.7) Show how interactions of the new fuel with the existing fuel, during transients and accidents, will not lead to a greater release of fission products that what is assumed as part of the licensing basis for the plant.

(A.8) Show how the use of the new fuel will not create additional activation products that will be released into the reactor coolant system, and then into the plant, increasing radiation doses to workers.

3. Does the proposed amendment involve a significant reduction in a margin of safety?

Response: No. "Operation of Braidwood Station Unit 1 or Unit 2 with up to eight TVEL TVS–K LTAs, placed in nonlimiting core locations, does not change the performance requirements on any system or component such that any design criteria will be exceeded."

(A.9) The Braidwood cores, if fully loaded with TVS-K LTA fuel assemblies will have an available coolant flow area that will be reduced by almost 8%. The reduction in coolant flow area could be viewed as an increase in core bypass flow. According to the Braidwood UFSAR, the core bypass flow is specified to be not more than 8.3%. Therefore, a core that is fully loaded with TVS-K LTA fuel assemblies could have a core bypass flow that is almost twice as large the currently licensed value. It is reasonable to ask whether EGC or the NRC staff have evaluated the potential reduction in the safety margin (i.e., core thermal margin) that could result from the reduction in coolant flow area (or increase in core bypass flow), its effect upon Braidwood's accident analysis results. Would this be a reduction in the safety margin?

<u>(B.) Design and Operations Considerations</u>

(B.1) This LAR requests approval for the first of many potential uses of TVS-K fuel assemblies in American reactor cores. What role, if any, will the Advisory Committee on Reactor Safeguards (ACRS) play in its evaluation?

(B.2) The Braidwood TVS-K LTAs will be fabricated by TVEL, in Russia, in accordance with 10 CFR 50 Appendix B Quality Assurance programs. However, TVEL intends to notify GNF-A of any fabrication issues. GNF-A will be responsible for evaluating potential 10 CFR 21 reportability issues. EGC will provide surveillance/ quality oversight during fabrication of the LTAs. Which organization will notify the NRC staff, if/when that's necessary?

(B.3) EGC will ensure, with input from GNF-A, that the LTAs will not be limiting in terms of thermal and reactivity margins. Confirmatory evaluations will be performed to demonstrate that the TVS-K LTAs will satisfy the inputs and assumptions of the current AOR. (The Westinghouse analytical codes and methods

used for currently licensed fuel design and reload analysis will be used to confirm that the TVS-K LTAs do not have a material adverse impact on the resident Westinghouse fuel.) What NRC-approved codes and methods do EGC and GNF-A possess that can demonstrate that the TVS-K LTAs will satisfy the inputs and assumptions of the current AOR, for Westinghouse PWRs?

(B.4) There is a new design of debris filters on these bundles. They are supposed to trap one or two errant bits of metallic debris before it gets into the core, gets caught on a spacer grid, and frets a hole in a fuel rod. They are supposed to catch debris. However, there is a separate, ongoing issue that is related to NPSH for ECCS pumps taking a suction from reactor building sumps. Screens have been installed to protect the pumps, and they affect the head loss on pump NPSH. How will TVEL address the fine debris that could pass through the screens and pumps, and collect at the inlet to each fuel bundle, where it could severely impede water flow up into the core from the lower plenum?

(B.5) EGC will need actual test data from irradiated fuel that is burned for design rated life, at design rated conditions. EGC will have to put the TVS-K LTAs into locations that are close to, but not quite, the limiting locations for the core design. However, if EGC intends to refuel more often (i.e., lower burnup operations), then less limiting locations can be selected, which will yield the data needed for lower burnup operations.

(B.6) The LAR mentions that data from certain GE computer codes will be used to qualify some aspects of the new fuel design data. Explain how data from a computer code can be used to validate data from another computer code.

(B.7) EGC claims that E110opt is "similar to M5 because it has the same chemical composition". Chemical composition does not address other, fabrication issues, which indicate that E110 is not nearly the same as M5. E110opt may be more “similar” to M5; but this claim will have to be verified by extensive testing.

(B.8) Indicate the status of the ongoing rulemaking regarding 10 CFR 50.46c, particularly with the issues related to cladding embrittlement.

(B.9) Westinghouse has developed analytical codes and methods for its supply of Westinghouse hexagonal fuel assemblies for the Temelin plants in the Czech Republic. This required Westinghouse to generate their own T/H data for the hexagonal elements and the mixing grids, and they were specifically tested for the hexagonal geometry. Describe the analytical codes and methods that will be used to support TVEL’s supply of square fuel assemblies, and new cladding materials for Westinghouse plants.

(B.10) The LAR claims that analyses "will be done to demonstrate that the changes will not be significant". What, if any, analyses have actually been performed to support the claim that the changes will not be significant?

(B.11) Where is the evidence to show that the TVEL’s quality assurance program complies with the requirements of Appendix B, including all suppliers for material, equipment, and parts? Also, have the tests and analyses that have been performed by TVEL “by qualified personnel” been done in accordance with all of the requirements of Appendix B? What “recognizable standards” were used? The document states that the “Testing output has been documented and the configuration is controlled”, but have these reports been submitted and reviewed by the NRC for compliance with Appendix B?

(B.12) Where is the evidence to show that TVEL has a training program to ensure that workers who design and build the fuel understand the requirements of Appendix B, especially the reporting requirements for deficiencies?

(B.14) EGC is not asking for an exemption from the regulations, even though E110opt and E635 fuel cladding alloys are not considered in the regulations. This issue has been raised in an internal non-concurrence letter (ML 19187A276), and it's the subject of a differing professional opinion that has been filed by another NRC staff member. We agree with all of the concerns expressed in ML18187A276. This application is a good example of the sort of problems that will arise if the staff allows the introduction of LTAs that use significantly different designs and new materials that have not been previously reviewed. The LAR is vague about the specific data and analyses that are supposed to be used to justify the safety of these new designs, but many of the important analyses have not been done, others are promised to be done at some time in the future, and "data" generated by computer codes will be authorized to stand in place of actual measured data from experimental test facilities. These practices do not constitute "good engineering judgment".

(B.15) Where is the evidence to show that TVEL's fuel design will comply with GDC 10, regarding fuel design parameters for normal, transient and accident performance. (See Criterion 10—Reactor design. "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 proposed letter to NEI that is the subject of ML18187A276 also addresses this issue. It is important because it involves the integrity of the first fission product barrier in the reactor core. Fuel suppliers are supposed to develop their own "specified acceptable fuel design limits", and ensure that they are not exceeded. The fuel design limits are supposed to be defined in approved topical reports that are reviewed by the NRC staff, or at the very least, the methods for establishing those design limits is supposed to be reviewed and approved. There does not appear to be any such documentation for these new LTAs.

(B.16) The regulatory framework, as discussed in ML18078A013, indicates that, "LTAs need to be analyzed with NRC staff approved codes and methods." With respect to fuel assemblies in a core reload, it states, "Furthermore, a nuclear core reload utilizing fuel assemblies with the following attributes could potentially represent a significant hazard due to a significant reduction in safety margin: (1) fuel assemblies different than those previously found acceptable to the NRC; and (2) fuel assemblies whose analytical methods have not been previously approved by the NRC."

<u>(C.) Trade Considerations</u>

The Russian company TVEL, which is part of the Rosatom state corporation, produces fuel for nuclear power reactors. It has supplied fuel for "78 nuclear power plants, in 15 countries, and for research reactors, and for reactors on ships of the Russian fleet".

Global Nuclear Fuel is a joint venture of GE, Toshiba and Hitachi, which is working with TVEL to supply nuclear fuel to Westinghouse PWRs, in the US.

(C.1) Describe the technology transfer agreements, if any, that exist between GE, Toshiba, Hitachi, TVEL, and Westinghouse.

(C.2) Has the NRC's Export Controls and Nonproliferation Branch reviewed the LAR with respect to sanctions that might be applicable to Rosatom and TVEL, (1) as Russian companies, and/or (2) as companies that are engaged in Iranian nuclear activities (e.g. Fordow, and Bushehr)? TVEL has indicated that one of the reasons it's entering the US market is Ukraine's refusal to buy its nuclear fuel. Ironically, Ukrainian nuclear plant operators won't buy TVEL's fuel; but EGC, America's largest nuclear plant operator, will.

(C.3) Describe the provisions, if any, that are proposed for disposition of the spent TVEL fuel assemblies. Will they be returned to TVEL? If yes, then would EGC be exporting plutonium to Russia?