Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

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Accept Regulatory Document for Publication

Approuver le document d'application de la réglementation

REGDOC-2.4.5, *Nuclear Fuel Safety and Qualification*

REGDOC-2.4.5, *Sûreté et qualification du combustible nucléaire*

Public Meeting

Réunion publique

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Submitted by:

CNSC Staff

Soumis par :

Le personnel de la CCSN

e-Doc 7159917 (WORD) - English
e-Doc 7215987 (PDF) - English
e-Doc 7216110 (WORD) - Français
e-Doc 7215990 (PDF) - Français

Summary

This CMD pertains to a request for a decision regarding:

- draft regulatory document REGDOC-2.4.5, *Nuclear Fuel Safety and Qualification*

CNSC staff recommend that the Commission consider taking the following action:

- accept draft REGDOC-2.4.5, *Nuclear Fuel Safety and Qualification*

The following items are attached:

- draft REGDOC-2.4.5, *Nuclear Fuel Safety and Qualification* [Appendix A]
- detailed comments table [Appendix C]

Résumé

Ce document à l'intention des commissaires (CMD) concerne une demande de décision au sujet de :

- l'ébauche du document d'application de la réglementation REGDOC-2.4.5, Sûreté du combustible nucléaire

Le personnel de la CCSN recommande à la Commission pourrait considérer prendre la mesure suivante :

- l'ébauche du REGDOC-2.4.5, Sûreté du combustible nucléaire

Les pièces suivantes sont jointes :

- l'ébauche du REGDOC-2.4.5, Sûreté du combustible nucléaire [Annexe B]
- le tableau des réponses aux commentaires reçus [Annexe C]

Signed/Signé le

6 February 2024 / 6 février 2024

Beaton, Dana

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TABLE OF CONTENTS

Executive Summary

Regulatory document REGDOC-2.4.5, *Nuclear Fuel Safety and Qualification*, clarifies requirements and provides guidance for the design, operation, monitoring, qualification, and performance assessments of fuel for operating reactor facilities.
This document would apply to Class I nuclear facility licensees.

At present, the CNSC's safety requirements and guidance on fuel and fuel-related systems and components for existing facilities are not captured in a regulatory document. This has resulted in a lack of regulatory clarity with respect to CNSC expectations on new fuel bundle designs, and in the potential for inconsistency in high-level requirements in the licence conditions handbooks (LCHs) of operating nuclear power plants and in regulatory oversight for inspection, monitoring and fuel fitness for service assessments.

This document consolidates existing requirements and guidance in a single document and does not intend to introduce new requirements.

While this regulatory document has an implicit focus on CANDU reactors, it is as technology neutral as practicable. When a design other than a CANDU reactor is considered for licensing in Canada, the associated fuel design, qualification and oversight will be subject to the safety objectives, high-level safety concepts and safety management requirements in this document, where applicable. Further, this document will be revised as appropriate to incorporate operating experience with new reactors and new fuel technologies.

The draft of REGDOC-2.4.5, *Nuclear Fuel Safety and Qualification*, was presented for public consultation from September 26, 2022, to January 28, 2023. CNSC staff received 188 comments. A workshop with commenters was held on July 19, 2023.

1 Overview

1.1 Background

At present, the CNSC’s safety requirements and guidance on fuel and related phenomena for existing facilities are not captured in a regulatory document. This could result in a lack of regulatory clarity and in the potential for inconsistency in both high-level requirements and in regulatory oversight.

CSNC staff’s assessment was that consolidating the requirements and guidance into a new regulatory document would capture existing expectations, knowledge and best practices.

This document consolidates requirements contained in existing licence condition handbooks (LCHs) and in official letters from the Directorate for Power Reactor Regulation (DPRR) to licensees. Since the regulatory document will consolidate existing expectations, it will not introduce new requirements.

1.2 Highlights

Draft REGDOC-2.4.5, *Nuclear Fuel Safety and Qualification*, is divided into five sections.

1. Fuel design management:
    - The licensee has a fuel design program.
    - The fuel design is controlled.
    - A fuel design authority is identified.
    - Fuel design limits have been established and fuel is operated within these limits.
    - The manufacturing quality assurance (QA) program meets national standards.

2. Fuel design / qualifying process:
    - Defence in depth is taken into account.
    - Safety analysis and design/qualification are linked.
    - Design requirements and safety objectives are documented.
    - Qualification demonstrates that the design meets the requirements and objectives.

3. Fitness for service:
    - Fuel fitness for service criteria are documented to the extent practicable.
    - The licensee can demonstrate compliance with the criteria.

4. Fuel monitoring and inspection:
    - Support REGDOC-3.1.1 reporting requirements.
    - Monitor the fuel condition.

- Ensure the fuel remains fit for service.
- Remove fuel that has failed or is not fit for service.

5. Operational limits and conditions (OLCs):
    - OLCs ensure the fuel remains within its design and qualification envelope; that is, fit for service.
    - The licensee assesses the adequacy of the OLCs before entering new operating conditions.
    - OLCs consider the impact of reactor facility aging.

Other objectives

- Improve management and retention of knowledge for licensees.
- Consolidate CNSC staff expectations and licensee commitments in one document.
- Simplify CNSC staff's work to verify compliance with requirements.
- Clarify regulatory requirements for proponents of novel fuels and operating strategies.

2 Indigenous and Public Consultation and Engagement

2.1 Indigenous Consultation and Engagement

CNSC staff concluded that the regular public consultation, communication and engagement activities were adequate for this document. REGDOC-2.4.5 did not require specific engagement or consultation with Indigenous Nations and communities. Many Indigenous Nations and communities are registered on the CNSC mailing list and were advised of the public consultation for the draft of REGDOC-2.4.5 by that means. The CNSC did not receive any specific requests from Indigenous Nations or communities for specific engagement or discussions on this draft document.

2.2 CNSC Public Consultation and Engagement

Consultation with the public, licensees and interested organizations was conducted from September 26, 2022, to January 28, 2023. The CNSC received:

- 188 comments
    - 78 from the CANDU industry
    - 99 from the SMR industry
    - 11 from individuals

A workshop with commentors was held on July 19, 2023.

Following the public consultation period, submissions from respondents were posted on the CNSC's website, from February 15, 2022, to March 2, 2022, for feedback on the comments received. No comments were received during the feedback period.

The following comments raised during public consultation may be of particular interest.

Comment 1: Placement in safety and control area (SCA)

Participants noted the document does not fit neatly into a single SCA.

CNSC staff response

SCAs are used as a way to organize the framework and are not always a perfect fit for every document. Participants agreed that SCA placement does not affect licensee business, operations, implementation or compliance. CNSC staff agreed to a name change to better reflect the contents of the regulatory document, rather than move the document to a different SCA.

Comment 2: Focus of document

Some participants felt that the document should be focused more on advanced fuels for new reactors, while other commenters thought that the document as written was CANDU-centric and should remain that way. A third option presented was to draft two separate documents.

Additionally, participants asked about the purpose of the document. For new reactors, they see it as a design document for defence in depth, fuel qualification, etc.

CNSC staff response

The CNSC will consider addressing advanced fuels (likely, in a revision to this regulatory document) specifically (for new reactors) when there is sufficient evidence that advanced fuels will be proposed for use in Canada through formal means.

The intent of the document is to consolidate information currently available in various sources into a single document, to provide regulatory certainty and clarity. CNSC staff reiterated that there is no intention to include new requirements for existing facilities, and that the key goals of the regulatory document are to:

- Capture historical information
- Clarify expectations for fuel design and qualification
- Clarify expectations for operational oversight
- Establish criteria for fuel performance

Lastly, having two separate documents would significantly delay the process, with little to no benefit. CNSC staff's experience with separating documents in this manner is that it creates challenges with consistency and clarity.

Comment 3: Duplication of requirements

Participants expressed concern that the document duplicated requirements and might introduce new requirements.

CNSC staff response

The intent was not to include new requirements for licensees; instead, it was to point to existing expectations for guidance. CNSC staff recognize that some requirements, for example several CSA standards, are already included in many existing facilities' licensing bases.

Comment 4: Third-party fuel designers and qualification

Participants expressed concern about the ability to use international fuel suppliers.

CNSC staff response

Participants were advised that the use of international suppliers would be permitted provided the CNSC is confident this would result in an equivalent or superior level of safety; justifications should be provided in these cases. CNSC staff added that they performed a scenario analysis, including the scenario of an international fuel supplier, to inform the writing of the regulatory document.

CNSC staff reiterated that licensees are ultimately responsible for safety, including when work is done by other vendors. The document can be used as a guide for discussions between licensees and their fuel vendors, as it contains information on what the licensee must do and be accountable for, that is, it clarifies the requirements of licensees for accepting fuel from third-party vendors.

Further, CNSC staff noted that the CNSC has experience with international fuel vendors that has informed the development of this regulatory document.

Comment 5: Technology neutrality

Some participants expressed concern about the CANDU-centric nature of the document.

CNSC staff response

CNSC staff noted that the intent was to make the document as technology neutral as practicable while still CANDU-centric. Some sections, such as those on inspections, are more difficult to make technology neutral, as fuel monitoring and inspection techniques, accessibility and requirements vary significantly between fuel and reactor types. CNSC staff noted that that some technologies will not be refuelled, and that in such cases alternative approaches would need to be proposed.

CNSC staff also noted that first-of-a-kind facilities using new technologies may require additional inspections as there may be uncertainties in fuel performance.

Participants asked how the document will evolve for non-CANDU fuel. CNSC staff responded that regulatory documents are periodically reviewed, and a document can be reopened at any time if there is a compelling case. Therefore, if new fuel technologies come online, REGDOC-2.4.5 could be revised.

Comment 6: Guidance on qualification

Some participants wanted more guidelines on the qualification stage. Specifically, they had questions about whether meeting NUREG-2246, *Fuel Qualification for Advanced Reactors,* also equates to meeting the requirements in REGDOC-2.5.2, *Design of Reactor Facilities*, for fuel qualification.

CNSC staff response

REGDOC-2.4.5 follows the International Organization for Standardization's (ISO's) 9000 series of standards, which cover quality management and quality assurance, wherein regulators establish design requirements and licensees establish how to meet the requirements.

CNSC staff noted the reference to NUREG-2246 and that it had been successfully used in the CNSC-USNRC joint review of TRi-structural ISOtropic (TRISO) fuel qualification. CNSC staff reiterated that they consider a gap analysis between REGDOC-2.5.2 and NUREG-2246.

Participants noted concerns that first-of-a-kind fuels may need more scrutiny or may have a less robust technical/experimental basis. CNSC staff noted areas for additional guidance, such as on the subject of fuel performance codes. Additionally, CNSC staff noted that first-of-a-kind scenarios would be better handled in the licensing process on a case-by-case basis until sufficient experience and data is gathered to document regulatory expectations in a regulatory document.

2.2.1 Conclusion

Participants in the workshop were satisfied by CNSC staff responses to their concerns.

3 Implementation

This document will be included in the existing licence conditions handbooks (LCHs) as a compliance verification criterion for Class I facilities, replacing any text on fuel regulation. The Regulatory Framework Division is working with the Power Reactor

Licensing and Compliance Integration Division (PRLCID) to develop an implementation plan.

4 Overall Conclusions and Recommendations

4.1 Overall Conclusions

Draft REGDOC-2.4.5, *Nuclear Fuel Safety and Qualification*, was developed through consultation with stakeholders and other interested parties. For existing licensees, it provides an important clarification to the CNSC’s regulatory framework. For new applicants, who are privy to existing licensing bases, it also provides an important addition to the CNSC’s regulatory framework.

CNSC staff conclude that REGDOC-2.4.5, *Nuclear Fuel Safety and Qualification*, is ready for acceptance by the Commission.

4.2 Overall Recommendations

CNSC staff recommend that the Commission accept REGDOC-2.4.5, *Nuclear Fuel Safety and Qualification*.

Glossary

For definitions of terms used in this document, see *REGDOC-3.6, Glossary of CNSC Terminology*, which includes terms and definitions used in the *Nuclear Safety and Control Act* and the *Regulations* made under it, and in *CNSC regulatory documents* and other publications.

Appendix A: REGDOC-2.4.5, Nuclear Fuel Safety and Qualification

Canada's Nuclear Regulator

Safety Analysis

Nuclear Fuel Safety and Qualification

REGDOC-2.4.5

November 2023

DRAFT

Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

Canada

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Preface

This regulatory document is part of the CNSC's safety analysis series of regulatory documents, which also covers deterministic safety analysis, probabilistic safety assessment and nuclear criticality safety. The full list of regulatory document series is included at the end of this document and can also be found on the CNSC's website.

Regulatory document REGDOC-2.4.5, *Nuclear Fuel Safety and Qualification*, clarifies requirements and provides guidance for the design, operation, monitoring, qualification and performance assessment of fuel for operating reactor facilities.

This document is the first version of REGDOC-2.4.5, *Nuclear Fuel Safety and Qualification*.

For information on the implementation of regulatory documents and on the graded approach, see REGDOC-3.5.3, *Regulatory Fundamentals*. [1]

The words "shall" and "must" are used to express requirements to be satisfied by the licensee or licence applicant. "Should" is used to express guidance or that which is advised. "May" is used to express an option or that which is permissible within the limits of this regulatory document. "Can" is used to express possibility or capability.

Nothing contained in this document is to be construed as relieving any licensee from any other pertinent requirements. It is the licensee's responsibility to identify and comply with all applicable regulations and licence conditions.

Table of Contents

Nuclear Fuel Safety and Qualification

1. Introduction

1.1 Purpose

This regulatory document clarifies the regulatory requirements and provides guidance for the design, operation, monitoring, qualification and performance assessment of nuclear fuel.

It articulates a set of comprehensive fuel-related regulatory requirements and provides risk-informed guidance that aligns with accepted national and international codes and practices.

1.2 Scope

This document focuses on fuel design, operation, monitoring, qualification and performance assessment for operating facilities, with implicit focus on operating CANDU reactors, but remains as technology-neutral as practicable. It applies primarily to existing fuel designs and to modified or new fuel designs envisioned for operating plants at the time of publication of this document.

The high-level concepts and technology-neutral information also apply to proposed new reactor facilities, including technologies other than water-cooled reactors. While this document focuses on CANDU fuel, high-level concepts herein may apply to other technologies. If a design other than a CANDU reactor, and specifically a solid-fuelled reactor design, is being considered for licensing in Canada, the associated fuel design, qualification and oversight will be subject to the safety objectives, high-level safety concepts and safety-management requirements associated with this regulatory document, where applicable.

Regulatory documents are applicable only if included in the licensing basis of the facility, such as being referenced in the licence conditions handbook. Given the wide range of fuel designs – especially that of advanced and small modular reactors, the applicant or licensee can take a risk-informed approach that includes grading and alternatives in accordance with REGDOC-3.5.3, *Regulatory Fundamentals*. [1]

This document will be revised as appropriate to incorporate operating experience (OPEX) with new reactor technologies.

1.3 Relevant legislation

The following provisions of the *Nuclear Safety and Control Act* (NSCA) and the regulations made under it are relevant to this document:

- NSCA, paragraph 3(a), subparagraph 9(a)(i), and subsections 24(4) and (5)
- *General Nuclear Safety and Control Regulations*, paragraph 12(1)(c)
- *Class I Nuclear Facilities Regulations*, paragraphs 6(b) and (g)

1.4 National and international standards

The key principles and elements used in developing this document are consistent with national and international standards.

The following standards are relevant to this regulatory document:

- CSA N286:12, *Management System Requirements for Nuclear Facilities* [2]
- CSA N299.1 series, *Quality Assurance Program Requirements for the Supply of Items and Services for Nuclear Power Plants* [3]
- IAEA SSG-52, *Design of the Reactor Core for Nuclear Power Plants* [4]
- NUREG-2246, *Fuel Qualification for Advanced Reactors* [5]

2. Fuel Safety

The primary safety functions of fuel are to retain all radionuclides within the fuel system to limit or prevent releases, maintain a coolable geometry, and support or not interfere with safe shutdown. A robust design, safety analysis, qualification and manufacturing process are used to produce the fuel, and strong operational oversight ensures that the fuel performs as expected.

Nuclear fuel is expected to retain its integrity under conditions of normal operation, including under the effects of anticipated operational occurrences (AOOs). Some degree of fuel failure can be accommodated for low-frequency design-basis accident (DBA) conditions (that is, those not expected to occur during the life of the plant). The ability to achieve safe shutdown in any scenario needs to be assured. Therefore, criteria need to be established to ensure that a coolable geometry is maintained in all scenarios and that fuel system damage is never so severe as to preclude the insertion of negative reactivity sufficient to hold the reactor subcritical.

The CNSC has formulated requirements and provided guidance regarding fuel design, degradation mechanisms and associated limits, qualification, monitoring, inspection and operations to ensure the application of defence in depth (DiD) principles to all fuel-related activities so that the fuel will perform in accordance with its design safety objectives during both operational states and accident conditions.

For more information on the concept and application of DiD, see REGDOC-3.5.3, *Regulatory Fundamentals*, [1] and REGDOC-2.5.2, *Design of Reactor Facilities*. [6]

3. Fuel Design

The fuel design must be controlled, accurately reflected in the safety analysis of the reactor facility, and properly qualified for the subset of all facility states considered in the fuel design process. Program measures must confirm that the fuel will remain within its safety limits at all applicable levels of DiD, where each safety limit is explicitly taken into account in the fuel design basis.

Requirements

Licensees shall have program measures that ensure that the fuel design is:

1. controlled
2. accurately reflected in the safety analysis of the reactor facility
3. properly qualified for the subset of all facility states considered in the fuel design process

4. within its safety limits at all applicable levels of DiD, where each safety limit is explicitly taken into account in the fuel design basis

3.1 Fuel design and fuel design limits

The licensee shall ensure that the fuel design and fuel design limits are established.

Requirements

The licensee shall ensure, for the fuel design, that:

1. all phases of the facility's lifecycle, and all levels of DiD, are taken into account
2. the fuel remains within its safety limits for the facility's design envelope
3. the design inputs are defined
4. the design requirements are defined
5. the design and safety analysis computer codes are validated
6. the fuel design is qualified for use

3.2 Control of fuel design and design process

Requirements

The licensee shall ensure that the fuel design, design process and manufacturing are established, documented and controlled.

The licensee shall ensure that the fuel documentation is updated when new information or understanding is gained.

Guidance

The licensee should ensure that fuel design and oversight comply with the management system requirements found in CSA N286:12, *Management System Requirements for Nuclear Facilities*, [2] or equivalent.

Measures for fuel design should include a manufacturing quality assurance (QA) program that ensures the supply chain for fuel and employs and justifies an appropriate standard supply chain QA, such as CSA N299.1, *Quality Assurance Program Requirements for the Supply of Items and Services for Nuclear Power Plants*. [3]

Licensees that are not using CSA N286:12 and/or CSA N299.1 should map their management system and QA control measures to the requisite standards to demonstrate that they satisfy the requirements for the fuel design process. Where gaps are identified, the licensee should ensure that the measures that address them are documented.

3.3 Fuel design authority

Requirements

The licensee shall identify a design authority or responsible designer for fuel, henceforth called the fuel design authority in this document, who is responsible for:

1. establishing a fuel design knowledge base that allows the licensee to understand and predict fuel behaviour for all plant operating states with established uncertainties
2. ensuring that the fuel design process was followed
3. controlling the documentation of the design and its technical basis
4. ensuring change control
5. ensuring the qualification of the fuel design for the application (see section 5.4)

Guidance

While activities may be carried out by third parties, the licensee remains responsible for compliance and safety.

4. Fuel Design Process

In the fuel design process, the designer identifies the requirements and limits the fuel must meet, produces a fuel design, and documents how the design meets the requirements. The fuel design process includes assessments that show how the fuel design requirements have been met. The complexity of the fuel design process, including the qualification stage, is a function of the novelty of the design. The design process must take into account all applicable facility states.

4.1 Design requirements

Requirements

The fuel design process shall identify:

1. functional requirements
2. performance requirements
3. safety requirements
4. environmental impact
5. inspection and testing requirements
6. requirements that are imposed on the interfacing systems by the fuel design
7. requirements that are imposed on the fuel by the interfacing systems
8. applicable codes and standards

Guidance

Applicable codes and standards should include those related to welding, transport packaging, workplace safety and the handling of hazardous materials.

Licensees should refer to CSA N286:12, *Management System Requirements for Nuclear Facilities* [2] for more information.

4.2 Design safety objectives

Requirements

The design process shall define the fuel design safety objectives.

Guidance

For current operating CANDU reactors, these objectives may be formulated as follows:

1. For normal operating conditions, including the effects of AOOs:
    a. fuel damage or degradation does not invalidate safety analysis assumptions
    b. fuel pellet, element and bundle dimensions will remain within operational tolerances
    c. the fuel bundle will maintain its structural integrity
    d. the functional capabilities of the fuel will not be reduced below those assumed in the deterministic safety analysis
    e. the damage that the fuel may cause to the fuel channel components is acceptable in the sense that these components remain fit for service
2. For accident conditions considered in the safety report (DBA):
    a. the fuel design achieves the safety functions commensurate with the event class
    b. fuel sheath failures will be kept as low as reasonably achievable (ALARA)
    c. the fuel assembly and its component parts will not remain in a position or have distortions that would prevent effective core cooling during or after the accident

If the fuel design is for a reactor other than a CANDU, the fuel design safety objectives shall be defined following international best practices and might differ significantly from the guidance provided for currently operating CANDU reactors.

4.3 Defence in depth

Requirements

The fuel design process shall take into account the core principles of level 1 DiD.

Guidance

Level 1 DiD should be achieved through:

1. careful selection of materials
2. use of qualified fabrication processes
3. use of proven technology
4. extensive performance testing
5. conservatism in the design
6. high quality in construction and manufacturing
7. use of appropriate standards
8. suitable safety margins
9. due consideration of facility design parameters and site characteristics

For more information on DiD, see REGDOC-3.5.3, *Regulatory Fundamentals*. [1]

4.4 Safety analysis

Requirements

Safety analysis shall begin at an early point in the fuel design process, with iterations between design activities and confirmatory analytical activities supported by experimental and qualification testing. The objective is to demonstrate an increase in scope and level of detail as the design process progresses.

4.5 Design consideration scope

Requirements

Reactor conditions, from commissioning to core end-of-life conditions, shall be taken into account in the design process.

Design considerations shall take into account all facility states within the facility's design envelope.

4.6 Input to design process considerations

Requirements

The design process shall document how the following were taken into account:

1. reactor physics and the nuclear design
2. reactor thermal hydraulics
3. nuclear criticality safety
4. interfacing systems such as:
    a. interfacing physical barriers (for example, the primary heat transport system components)
    b. fuel handling
    c. fuel storage
    d. transport
5. waste management, storage and minimization
6. OPEX

4.7 Degradation mechanisms

Requirements

The design process shall identify fuel degradation mechanisms and the performance limits associated with these mechanisms, which may challenge the fuel design. To this end:

1. damage mechanisms shall be identified and defined
2. failure mechanisms shall be identified and defined
3. conservatism shall be employed in setting limits associated with degradation mechanisms
4. limits associated with damage mechanisms shall be set such that, if complied with, they preclude, with margin, the fuel (element or bundle) and fuel channel components from being damaged (that is, the fuel and fuel channel components remain fit for service) during operational states
5. fuel damage and failure mechanisms and the associated limits shall reflect a verified and auditable knowledge base

Guidance

The design process should identify fuel failure limits. If a fuel failure limit is not well defined or known, a measurable surrogate limit should be defined. These surrogate limits should incorporate conservative engineering safety factors.

Appendix A provides examples of degradation mechanisms for CANDU reactors.

For more information on the concept and application of DiD, see REGDOC-3.5.3, *Regulatory Fundamentals*, [1] and REGDOC-2.5.2, *Design of Reactor Facilities*. [6]

4.8 Notification

Requirements

When considering possible changes to the fuel design, the licensee shall engage with CNSC staff to confirm that the changes are within the licensing basis before implementing the change.

Guidance

The CNSC encourages early engagement by the licensee to confirm that the changes are within the licensing basis.

4.9 Design change

Requirements

The licensee shall assess proposed changes to design specifications and manufacturing methods to determine whether the change can affect the licensing basis, design basis or safety case. If these might be affected, then the licensee shall treat the change as a design change.

Where the licensee is procuring a fuel design from a dedicated designer, the licensee must demonstrate that it has the technical processes and capabilities in place to assess and accept the requirements and limits the fuel must meet, including how the fuel is produced and how the fuel design is documented, to satisfy the licensee’s specific requirements for its facility.

4.10 Documentation

Requirements

The fuel design process shall document the fuel design and describe how it meets the identified requirements.

5. Fuel Qualification Process

Fuel qualification is a key activity of the fuel design process. The aim is to ensure that the final design meets all of the fuel design requirements. Fuel design qualification is achieved through analysis using qualified methods and through qualification testing.

5.1 Qualification objective

Requirements

As part of the qualification process, it shall be demonstrated that the design meets all of the requirements and the associated limits.

Guidance

A qualification process should rely on a systematic analysis of all available data and operational experience for identification of gaps in knowledge and potential new failure modes. A research and development program should be employed to address gaps in knowledge. When necessary, separate effect testing and integral testing should be performed to confirm safety limits and fuel acceptance criteria. The use of demonstration irradiation or lead test assemblies in conjunction with surveillance is encouraged.

The qualification process should include the qualification of the fuel manufacturing specifications and process.

When establishing the fuel qualification process, fuel designs for advanced reactors should use appropriate international guidance, such as NUREG-2246, *Fuel Qualification for Advanced Reactors*. [5]

5.2 Technical basis

Requirements

The technical basis for the qualification process:

1. is based upon OPEX or is demonstrated through a process of experimental testing and analysis, or a combination of both, where:
    a. any referenced OPEX must be documented and auditable
    b. OPEX or experimental tests may be with the same or similar fuel design in the same or a similar reactor design; for any technical basis that is based upon “similar designs,” the licensee shall document and assess the differences between both designs.
2. demonstrates the adequacy of:
    a. the qualification analysis and modelling
    b. the qualification testing regime
    c. the documented design and operating envelope of the fuel
3. shall reflect a verified and auditable knowledge base

Guidance

The technical basis for the qualification should show that the fuel is qualified for use by demonstrating that the evaluation models/codes used and the experimental data are appropriate and based upon sound science and techniques; that uncertainties, gaps and limitations with the models and experimentation are understood; and that cliff edge effects have been identified.

The models/codes should be verified and validated to the extent practicable against appropriate national standards, such as CSA N286.7, *Quality Assurance of Analytical, Scientific and Design Computer Programs*, [7] and be applicable over the range of the fuel performance envelope for which they are employed.

5.3 Management system and quality assurance

Requirements

The qualification process shall meet the licensee's management system and QA requirements.

5.4 Qualification certification

Requirements

The licensee shall ensure that the qualification of the fuel is certified by the licensee's fuel design authority.

Guidance

The certification of the fuel qualification is a written attestation that states that the fuel design authority has reviewed the design, accepted the qualification, and approved the use of the fuel design on behalf of the licensee. The attestation should demonstrate that the licensee fuel design authority is professionally qualified to be the design authority and has taken professional responsibility for ensuring that the fuel design is safe to use in the licensed facility.

6. Fuel Design Submissions

Requirements

Before loading a new or modified fuel design into a reactor core, the licensee shall submit, to the CNSC, the following information and obtain CNSC staff's confirmation that the design is within the licensing basis and is qualified for use:

1. for a modified fuel design, an assessment on whether or not the change is a licensing basis change
2. the fuel design requirements
3. a detailed description of the fuel design
4. the current/updated safety case
5. the technical basis for qualification
6. the documented qualification envelope
7. a summary of the qualification results
8. the certification of the qualification by the licensee's fuel design authority (see section 5.4)

Additional information shall be provided if requested by CNSC staff.

Guidance

The CNSC encourages early engagement for assessments of new or modified fuel designs.

For demonstration irradiations, where the number of bundles to be irradiated remains small, the graded approach may be employed.

For new reactor designs, the information pertaining to the fuel is expected to be part of the application for a licence to construct the facility.

7. Fuel Fitness for Service

Safe operation of fuel requires that the fuel conditions meet the criteria for fuel fitness for service (FFS). In this context, FFS is the physical condition necessary for the fuel barriers to remain intact, the fuel system dimensions to remain within operational tolerances, the structural integrity to be maintained, fuel parameters to remain consistent with the initial conditions assumed by the safety analysis report, and the fuel to remain compatible with interfacing systems such as the fuel channel components.

Typically, FFS assessments are performed through continual monitoring and inspection during normal operations and through post-AOO/DBA event reviews.

7.1 Fuel fitness for service criteria

Requirements

The licensee shall ensure that the fuel FFS criteria are identified and documented, to the extent practicable.

Guidance

The licensee should consider and the criteria should be consistent with:

1. the requirements placed on the fuel through the design and qualification process
2. licensing limits
3. OPEX
4. the challenges to which the fuel is subjected by AOO events
5. requirements for return to service after an AOO or DBA event

7.2 Technical basis

Requirements

The licensee shall have a documented technical basis for the set of FFS criteria and a methodology to demonstrate compliance.

7.3 Fuel fitness for service assessments

Requirements

The licensee shall implement a process that:

1. identifies when fuel FFS assessments are required
2. assesses fuel FFS

Guidance

FFS assessments should be performed with the intent of understanding degradation mechanisms and their respective degradation rate(s).

Computer codes used to perform FFS assessments should be validated for the application and should comply with appropriate national standards, such as CSA N286.7, *Quality Assurance of Analytical, Scientific and Design Computer Programs*. [7]

7.4 Record keeping

Requirements

The licensee shall keep records on the fuel condition as determined or inferred by operational data, inspections and/or assessments.

8. Fuel Monitoring and Inspection Program

The fuel monitoring and inspection program identifies the condition of the fuel and the extent of qualitative or quantitative graded degradations to determine whether the fuel remains fit for service.

Monitoring and fuel inspection activities play an important role in ensuring acceptable safety performance in a number of safety and control areas, including operating performance, physical design, and safety analysis. Information gathered during those activities ensures that events that are significant to safety and that occur at various levels of DiD are promptly detected, allowing adequate time for corrective measures to be effectively implemented to avoid repetitions.

8.1 Program

Requirements

The licensee shall establish a monitoring and inspection program that ensures that the fuel is fit for service.

Guidance

The monitoring and inspection program should:

1. confirm that fresh fuel's condition is acceptable before irradiation, such as by confirming the absence of foreign material or mechanical damage
2. monitor fuel conditions in the core to detect degradation or failure, such as by monitoring the coolant for radionuclides
3. ensure that fuel that is reshuffled is fit for service, either through analysis limits or inspection
4. infer the condition of fuel in the core by post-irradiation inspections
5. monitor fuel degradation rates

The monitoring and inspection of irradiated fuel as part of waste management is beyond the scope of this document.

8.2 Capabilities

Requirements

The licensee shall ensure that the monitoring and inspection program includes in-core monitoring, onsite inspections of fresh fuel, inspection of in-bay irradiated fuel and, if necessary, hot-cell examinations.

The fuel monitoring and inspection program shall:

1. have instrumentation or chemical sampling capabilities to identify fuel degradation or failure
2. require that only trained personnel perform inspections
3. include procedures and guidance on how to perform inspections
4. require that properly functioning and calibrated testing, measurement and inspection equipment be available
5. ensure the capability to perform the number of inspections required
6. require that equipment and qualified personnel needed to perform online fuel condition monitoring are sufficiently available
7. create and maintain a repository for recording fuel inspection findings

Guidance

The objective of the fresh fuel inspections is to ensure that the incoming fuel was manufactured in accordance with the appropriate quality standard and that the fuel has not been damaged or contaminated by transportation or storage. Once fresh fuel inspections are completed, the licensee should minimize interactions with the fuel prior to loading.

The objective of irradiated fuel inspections is to infer the existing in-core condition of the fuel and to trigger mitigating measures when required.

Data obtained from irradiated fuel inspections can also be useful in assessing whether fuel, under accident conditions, will perform in accordance with its design safety objectives and whether operators can take the necessary measures during postulated accident conditions.

8.3 Assessment of findings

Requirements

As part of the fuel monitoring and inspection program, the licensee shall regularly assess findings, trends, causes and their potential impacts and confirm that fuel remains fit for service and within the analyzed condition.

Guidance

The licensee should ensure that expertise from a diverse range of disciplines is involved in the program and in the assessment of findings. Some examples of disciplines that should be involved are fuel channels, safety analysis, fuel handling and reactor physics.

The impact on interfacing systems should be considered as part of the program.

8.4 Reporting

Requirements

The licensee shall report program findings in accordance with REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*. [8]

8.5 Corrective actions

Requirements

The licensee shall ensure that the fuel monitoring and inspection program identifies findings that have potential impacts on fuel FFS or on the analyzed condition and takes corrective or mitigating actions proportional to the level of risk presented.

8.6 Trending

Requirements

The licensee shall define levels related to expected fuel conditions and degraded states in order to identify negative trends.

Guidance

Training on fuel condition and degraded state levels should be a component of a fuel inspector's qualification to ensure that the data collected for trending is consistent and properly categorized.

8.7 Inspection process

Requirements

Where sampling is used, the licensee shall ensure that there is a documented inspection sample selection process.

The sample selection process shall include both random surveillance and targeted surveillance components.

Guidance

Generic surveillance, using random selection, should make up the majority of inspections.

Targeted surveillance should result in the selection of fuel samples that represent different conditions in the reactor.

The fuel inspection process should produce a robust plan for inspections, including the number of inspections that should be performed each quarter in order to meet annual inspection requirements (section 8.8).

8.8 Inspection

Requirements

For CANDU reactors, the minimum number of in-bay inspections for a normally operating reactor with no identified active degradation mechanisms is 20 bundles per normal operating year per reactor. For reactors of other designs, the licensee shall seek approval from the CNSC on an acceptable minimum level of inspections.

Additional inspections shall be performed when active degradation mechanisms or other challenges are present.

Guidance

Fuel removed from the core because it is not, or is suspected of not being, fit for service should be inspected to understand, document and address the root cause of the fitness for service concern.

Inspections done on fuel defects, in excess of the number typically performed for an operating year, should not be credited toward the minimum level of inspections. In cases where the fuel has been removed but the exact location (bundle or element) of the defect cannot be determined, all known information should be recorded.

A normal operating year is considered to be the expected full power operating time for a reactor of that technology considering its typical capacity factor. The number of inspections required can be prorated to account for long outages or refurbishment activities.

8.9 Maintenance of equipment

Requirements

The licensee shall ensure that equipment used to monitor for, locate and remove fuel that is not fit for service is capable and is functional when required.

Guidance

Monitoring equipment should be operating whenever the reactor is operating. Location and removal equipment is only required when fuel defects are detected.

8.10 Failed fuel and fuel not fit for service

Requirements

The licensee shall remove fuel that has been identified as failed or as not meeting the FFS criteria. If the fuel cannot be removed in a timely manner, the licensee shall take appropriate mitigating actions in the interim.

Guidance

The licensee should minimize failed fuel residency times, as fission product releases into the coolant and deposition on the primary heat transport system piping may result in higher worker doses.

The licensee should apply the ALARA principle when determining the resources and efforts being put toward failed fuel detection, removal and/or mitigation. Radiation doses received by personnel as a result of such efforts shall be kept ALARA.

8.11 Record keeping

Requirements

The licensee shall keep records of the fuel monitoring and inspection findings in a manner that is usable for analysis and trending.

9. Fuel Operating Limits and Conditions

Program measures shall ensure that fuel is operated within its design and operating envelope.

Operational limits and conditions (OLCs) to ensure that fuel is not damaged or the cause of damage to other barriers during normal operations or AOO conditions shall be set. The OLCs also provide a documented limit to degradation on the fuel to ensure that fuel remains within the design and qualification envelope.

9.1 Establishment principles

Requirements

The licensee shall establish fuel OLCs to ensure that fuel is operated in accordance with the licensing basis, the design of the reactor, and the qualification and operating envelope. The fuel OLCs shall include the limits within which the operation of the fuel has been shown to be safe.

9.2 Fitness for service

Requirements

The OLCs shall employ the FFS criteria defined in section 7.1 during and following all operational states, to the extent practicable.

9.3 Modes of operation

Requirements

The licensee shall use the fuel OLCs to establish the operational requirements applicable to each operating configuration before entering that configuration.

Planning and execution of new-build commissioning, refurbishment and post-refurbishment operations shall implement preventive measures that duly account for potential conditions that could result in fuel defects or damage.

Guidance

The operating configurations for normal operating conditions can include:

- cold shutdown
- hot shutdown
- power production operation
- refuelling
- shutting down
- starting up
- commissioning
- transitional states (moving from shutdown to full power)
- maintenance or outage
- life extension or refurbishment
- testing

For commissioning, refurbishment and post-refurbishment operations, the licensee should consider situations where fuel may be in-core and subject to non-standard conditions such as primary heat transport system (PHTS) pressure testing or hot conditioning.

Examples of preventive measures include chemistry control and foreign material exclusion practices.

9.4 Entering new operating conditions

Requirements

The licensee shall assess the fuel OLCs before entering operating conditions that are infrequent in nature. This assessment shall ensure that the existing fuel OLCs are adequate to ensure safety and FFS.

9.5 Aging

Requirements

In the fuel OLCs, the licensee shall take into account the impact of aging of the PHTS on fuel performance.

9.6 Corrosion

Requirements

The licensee shall define the operating parameters to minimize, within acceptable limits, corrosion of the sheath and the creation of deposits.

9.7 Changes in operation

Requirements

The licensee shall review significant changes to the operation of fuel and fuel handling against the fuel OLCs and update the fuel OLCs as required.

Guidance

Significant changes are those that potentially could affect neutronics, thermal hydraulics, or safety analysis assumptions, inputs or limits.

Examples of significant changes include:

- an increase in plant power rating
- an increase in burn-up
- major changes to the facility’s PHTS
- changes in fuel placement/shift or fuelling direction

9.8 Periodic review

Guidance

The licensee should undertake periodic reviews of fuel OLCs to ensure that they remain applicable and are updated as needed.

9.9 Action limits and response timelines

Requirements

The licensee shall define and address actions and the timelines for taking action when fuel is not or is suspected of not being FFS.

9.10 Documentation of basis

Requirements

The licensee shall ensure that the basis on which the OLCs are derived is readily available in order to facilitate the ability of plant personnel to interpret, observe and apply the OLCs.

Appendix A: Key Degradation Mechanisms

This appendix lists the key degradation mechanisms for CANDU fuel, in normal operating conditions and in some cases anticipated operational occurrences. For other reactor designs and configurations, degradation mechanisms may be similar or unique to the fuel design.

Table A-1: Key degradation mechanisms affecting CANDU fuel

Degradation category	Observable effect	Key influencing parameters	Impacts relevant to safety
Deformation without material loss	• Sheath collapse and ridging	• Coolant pressure • Temperature	• Mechanical strength • Heat transfer
	• Sheath ballooning (uniform) or bulging (non-uniform)	• Internal gas pressure • Temperature	• Mechanical strength • Heat transfer • Loss of sheath integrity
	• Pellet/cladding mechanical interaction	• Power ramps	• Loss of sheath integrity
	• Element bowing	• Loads • Temperature	• Mechanical strength • Heat transfer
	• End-plate deformation	• Loads	• Mechanical strength • Heat transfer
	• Bundle drooping, sagging	• Loads	• Mechanical strength • Heat transfer
	• Athermal sheath strain	• Loads	• Loss of sheath integrity
Deformation with material loss	• Fretting	• Interaction with debris	• Loss of sheath integrity
	• Bearing pad wear	• Interaction with pressure tubes	• Heat transfer • Impact on pressure tube condition
	• Spacer wear	• Interaction with pressure tubes	• Heat transfer
	• Endplate wear	• Interaction between fuel bundles	• Fuel bundle structural integrity
	• Scratching, nicks	• Interaction with in-reactor components	• Loss of sheath integrity
Change in material properties	• Sheath oxidation	• Temperature • Coolant chemistry	• Mechanical strength • Heat transfer
	• Oxide or crud deposits	• Temperature • Coolant chemistry	• Heat transfer • Poison hideout

Degradation category	**Observable effect**	**Key influencing parameters**	**Impacts relevant to safety**
	• Hydriding	• Coolant chemistry	• Mechanical strength • Sheath temperature
	• Stress corrosion	• Power ramps • Internal gas composition	• Loss of sheath integrity
	• Crevice corrosion	• Coolant chemistry	• Impact on pressure tube condition
	• Material phase transitions	• Temperature • Irradiation	• Mechanical strength
	• Fuel grain growth	• Temperature • Irradiation	• Heat transfer
	• Internal gas pressure and composition change	• Burn-up • Temperature	• Heat transfer • Stress corrosion
Integrity failures	• End-cap to sheath weld failures	• Manufacturing defects • Loads	• Loss of sheath integrity
	• End-cap to end-plate weld breaks	• Manufacturing defects • Loads • Fatigue	• Mechanical strength
	• End-plate cracks	• Vibration • Loads • Fatigue	• Mechanical strength

Appendix B: Acceptance Criteria for CANDU Design-Basis Accidents

This appendix shows examples of acceptance criteria for design-basis accidents. For other reactor designs and configurations, the designer and the licensee are expected to derive the acceptance criteria and justify them as appropriate based on the level of available supporting evidence.

Table B-1: Examples of CANDU fuel system acceptance criteria for design-basis accidents

Barrier to fission product releases or fundamental safety function	Qualitative acceptance criteria as derived acceptance criteria
Fuel matrix	• No fuel centre line melting • No fuel breakup • No excessive energy deposition

Fuel sheath (fuel cladding)	• No excessive strain of fuel sheath
	• Fuel elements are to meet applicable limits for:
	  o sheath temperature
	  o local sheath oxidation
	  o oxygen embrittlement of fuel sheath

Fuel assembly	• Maintain fuel coolability • Retain rod-bundle geometry or fuel assembly with adequate coolant channels to permit removal of residual heat • No impediment to reactor shutdown means because of geometry change

Glossary

For definitions of terms used in this document, see REGDOC-3.6, *Glossary of CNSC Terminology*, which includes terms and definitions used in the *Nuclear Safety and Control Act* and the regulations made under it, and in CNSC regulatory documents and other publications. REGDOC-3.6 is provided for reference and information.

The following terms are either new terms being defined or include revisions to the current definition for that term. Following public consultation, the final terms and definitions will be submitted for inclusion in the next version of REGDOC-3.6, *Glossary of CNSC Terminology*.

auditable knowledge base

A knowledge base that has the ability to track the knowledge within, back to the origins of that knowledge, such as a given experiment or calculation.

fuel design
The design of the system that provides, supports, controls, cools and contains the fuel matrix. Holistically, this includes groupings of fuel components into bundles, assemblies, piles and fuel strings.

fuel design authority

Either the design authority or the responsible designer for fuel assigned by the design authority.

functional performance

A requirement that specifies the mandatory functions or behaviours of an item.

performance requirement

A requirement that provides reasonable assurance that the facility can be operated without undue risk to the health and safety of the public.

verified knowledge base

A knowledge base that has confirmed that the information within meets the quality standards of the organization.

References

The CNSC may include references to information on best practices and standards such as those published by CSA Group. With permission of the publisher, CSA Group, all nuclear-related CSA standards may be viewed at no cost through the CNSC web page "How to gain free access to all nuclear-related CSA standards."

1. Canadian Nuclear Safety Commission (CNSC), REGDOC-3.5.3, *Regulatory Fundamentals*, Ottawa, Canada, 2023.

2. CSA Group, CSA N286:12, *Management System Requirements for Nuclear Facilities*, Toronto, Canada, 2012.

3. CSA Group, CSA N299.1 series, *Quality Assurance Program Requirements for the Supply of Items and Services for Nuclear Power Plants*, Toronto, Canada, 2019.

4. IAEA, SSG-52, *Design of the Reactor Core for Nuclear Power Plants*, Vienna, Austria, 2019.

5. United States Nuclear Regulatory Commission, NUREG-2246, *Fuel Qualification for Advanced Reactors,* Washington DC, United States of America, 2022.

6. CNSC, REGDOC-2.5.2, *Design of Reactor Facilities*, Ottawa, Canada, 2023.

7. CSA Group. CSA N286.7, *Quality Assurance of Analytical, Scientific and Design Computer Programs*, Toronto, Canada, 2016.

8. CNSC, REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*, Ottawa, Canada, 2016.

9. IAEA, TECDOC No. 1926, *Technical Review Of Acceptance Criteria For Pressurized Heavy Water Reactor Fuel*, Vienna, Austria, 2020.

Additional Information

The CNSC may recommend additional information on best practices and standards such as those published by CSA Group. With permission of the publisher, CSA Group, all nuclear-related CSA standards may be viewed at no cost through the CNSC web page "How to gain free access to all nuclear related CSA standards".

The following documents provide additional information that may be relevant and useful for understanding the requirements and guidance provided in this regulatory document:

- Canadian Nuclear Safety Commission (CNSC), REGDOC-2.4.1, *Deterministic Safety Analysis*, Ottawa, Canada, 2014.
- CNSC, REGDOC-2.5.2, *Design of Reactor Facilities*, Ottawa, Canada, 2023.
- United States Department of Defense, Systems Engineering Fundamentals, Washington DC, United States of America, 2001.

CNSC Regulatory Document Series

Facilities and activities within the nuclear sector in Canada are regulated by the CNSC. In addition to the *Nuclear Safety and Control Act* and associated regulations, these facilities and activities may also be required to comply with other regulatory instruments such as regulatory documents or standards.

CNSC regulatory documents are classified under the following categories and series:

1.0 Regulated facilities and activities

Series
- 1.1 Reactor facilities
- 1.2 Class IB facilities
- 1.3 Uranium mines and mills
- 1.4 Class II facilities
- 1.5 Certification of prescribed equipment
- 1.6 Nuclear substances and radiation devices

2.0 Safety and control areas

Series
- 2.1 Management system
- 2.2 Human performance management
- 2.3 Operating performance
- 2.4 Safety analysis
- 2.5 Physical design
- 2.6 Fitness for service
- 2.7 Radiation protection
- 2.8 Conventional health and safety
- 2.9 Environmental protection
- 2.10 Emergency management and fire protection
- 2.11 Waste management
- 2.12 Security
- 2.13 Safeguards and non-proliferation
- 2.14 Packaging and transport

3.0 Other regulatory areas

Series
- 3.1 Reporting requirements
- 3.2 Public and Indigenous engagement
- 3.3 Financial guarantees
- 3.4 Commission proceedings
- 3.5 CNSC processes and practices
- 3.6 Glossary of CNSC terminology

Note: The regulatory document series may be adjusted periodically by the CNSC. Each regulatory document series listed above may contain multiple regulatory documents. Visit the CNSC's website for the latest list of regulatory documents.

Appendix B: REGDOC-2.4.5 Detailed Comments Table

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
1.	OPG, Bruce Power, NB Power, CNL, CNA	Overview	Industry appreciates the opportunity to comment on the proposed new REGDOC-2.4.5, *Nuclear Fuel Safety*. Our commentary focuses on improving the clarity of the final document, but more importantly seeks clarification on the purpose, need, application and scope of the document. Following a collective review including safety analysis, fuel handling, fuel and physics, fitness for service, inspections, and supply chain personnel; licensees have identified several areas requiring clarification as well as several areas of significant concern. The feedback is broken in to Major or requests for Clarification comments. Of note, below we highlight several themes, which are of particular importance and supported by the comments identified as Major. These include: • *REGDOC Objective and Target Audience:* The document needs a clear objective. It is very CANDU-centric, particularly in the examples provided; however; Industry questions the need for a REGDOC targeting the mature, well-established (and CNSC approved) fuel designs of existing facilities. There is an opportunity to focus this document towards the new fuel designs being developed to support advanced nuclear reactors; exempting its application to existing facilities or at a minimum ensuring there is no expectation of retroactive application on existing fuel designs. • *Scope:* While the document numbering and title suggests this document is focused on nuclear safety analysis, it is more relevant to elements of fuel design, manufacturing (quality control) and monitoring and inspections. This document may be better served to remove the limited elements of safety analysis and focus on these other elements. • *Duplication:* Much of the safety analysis elements in this document are duplication from the existing REGDOCs, primarily REGDOC-2.4.1, *Deterministic Safety Analysis* and REGDOC-2.5.2, *Design of Reactor Facilities*. It would be more effective to remove the redundancy from this document and add any new safety analysis elements to the relevant existing REGDOCs.			At present, the CNSC's safety requirements and guidance on fuel and related phenomena for existing facilities are not captured in a REGDOC. This has resulted in a lack of regulatory clarity with respect to CNSC expectations on new fuel bundle designs, the potential for inconsistency in high-level requirements in the LCHs of operating NPPs and in regulatory oversight for inspection, monitoring and fuel fitness for service assessments. This document consolidates requirements contained in existing licence conditions handbooks (LCH) and in official letters from the Directorate for Power Reactor Regulation (DPRR) to licensees stating regulatory positions and requirements to individual licensees. Since the REGDOC will consolidate existing expectations, it will not introduce new requirements. While it has an implicit concentration on CANDU reactors, it is as technology neutral as practicable, with high-level concepts and technology-neutral information applicable to proposed new reactor facilities, including technologies other than water-cooled reactors. If a design other than a CANDU reactor is being considered for licensing in Canada, the associated fuel design, qualification and oversight will be subject to the safety objectives, high-level safety concepts and safety management requirements in this document, where applicable. Further, this document will be revised as appropriate to incorporate operating experience (OPEX) with new reactor technologies. The benefits of this document are: • Improves management and retention of knowledge for licensees. • Consolidates CNSC and licensee commitments in one document, rather than relying on LCHs and official letters from DPRR. • Simplifies verification and compliance activities

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
			In summary, this document has major implications on a mature well-established CANDU fuel design. It is unclear what value the application of this document will have to the existing fuel designs. Industry has implemented many successful fuel design changes and change control processes over the last many years, which have been approved by the CNSC. The document objective would better serve the future fuel designs supporting the development of advanced nuclear reactors.			• Greater regulatory clarity for proponents of novel fuels and operating strategies.
2.	OPG, Bruce Power, NB Power, CNL, CNA	General	MAJOR The documented is very CANDU-centric, essentially all with regards to the examples. As written, this regulatory document applies primarily to fuel programs of existing reactors, which are mature and well established with minimal need for this document. Although high-level concepts presented in the document may apply to other technologies, these new technologies are not specifically targeted. This seems to be a missed opportunity as a number of new reactor (and fuel) designs are being considered in Canada. The document should consider specifics of fuel safety for different types of reactors/fuels and acknowledge in more detail the specifics of the different stages of the fuel lifecycle (e.g., research, development, design, testing, operation, disposal).	Expand scope providing guidance for new fuel programs and fuel designs including fuels for advanced reactors would be more useful for advanced reactor vendors; for example, NEA's Regulatory Perspectives on Nuclear Fuel Qualification for Advanced Reactors (DRAFT), US NRC's "Fuel Qualification for Advanced Reactors" and Joint US NRC/CNSC reports on Tristructural Isotropic (TRISO) Fuel Qualification.	Useful for non-CANDU utilities and vendors to have regulatory guidance for evaluating compliance with CNSC fuel requirements. It is less useful for the mature, well-established fuel programs for the existing CANDU fleet.	The REG framework is intended to be a continually evolving. Future revisions may be needed to tackle this issue. At the moment we intend to keep our expectations high level for advanced reactor designs. NUREG-2246, *Fuel Qualification for Advanced Reactors* has been included as guidance.
3.	OPG, Bruce Power, NB Power, CNL, CNA	Preface & Section 1	MAJOR The document title is "Safety Analysis – Nuclear Fuel Safety" and the preface says it is "*part of the CNSC's safety analysis series of regulatory documents, which also covers deterministic safety analysis, probabilistic safety assessment and nuclear criticality safety*"…."*clarifies requirements and provides guidance for the design, operation, monitoring and safety assessments of fuel for operating reactor facilities*." The title and its association with other regulatory document from Safety Control Area 4 – Safety Analysis implies it falls within the jurisdiction of nuclear safety analysis and is for analysts who perform it.	To be consistent with the name of the REGDOC, remove requirements and guidelines for disciplines outside of the area of Nuclear Safety Analysis and Safety Analysts. Alternatively, remove Nuclear Safety analysis from the document. Requirements and guidelines in those jurisdictions or disciplines should be provided to Designers, Procurement, Suppliers, Inspectors, Fitness for Service, Operation and Maintenance personnel. There is a limited amount, if any, new Nuclear Safety Analysis requirements and guidelines that aren't already identified in REGDOC-2.4.1, *Deterministic Safety Analysis*. If fuel aspects are important, add the new information to REGDOC-2.4.1, *Deterministic Safety Analysis* and have	Having the same requirements in two different REGDOCs may cause future confusion and configuration management problems, particularly if they are managed by different Regulatory Directorates.	CNSC staff recognize that fuel is a cross cutting subject matter and believe there is value in having all of the fuel related requirements in one document instead of spread throughout the regulatory framework. As such there is no perfect home for Fuel Safety as it could easily fit into several SCAs. Ultimately though the SCA framework is a method to organize the framework and thus the category that fuel safety falls into does not impact its value. REGDOCs in associated SCAs will point to REGDOC-2.4.5.

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
				the rest of the document cover aspects outside of Nuclear Safety.		
4.	OPG, Bruce Power, NB Power, CNL, CNA	Section 1.1	Clarification Change "…clarifies the requirements.." to "…clarifies the regulatory requirements…"	Reword.		Agreed. Wording changed as suggested
5.	OPG, Bruce Power, NB Power, CNL, CNA	Section 1..	Clarification "*The regulatory document clarifies the requirements and provides guidance for the …and safety assessments of fuel*". The words "safety assessment" are used in 1.1 and 1.2 only. They are not used again in the document.	If the assessments are design or operational assessments elsewhere in this document, then please keep consistent terminology.		Agreed. Wording changed to address that these are qualification and performance assessments. This working lines up with the sections of the document.
6.	OPG, Bruce Power, NB Power, CNL, CNA	Sections 1.1 & 1.2	Clarification "*for operating facilities*" "*to new fuel designs envisioned for operating plants at the time of publication*" 1.2 is wider reaching than 1.1. The subsections are inconsistent.	Clarify actual scope of document?		The purpose has been made broader, by stating it is for nuclear fuel.
7.	OPG, Bruce Power, NB Power, CNL, CNA	1.2 Scope First paragraph	MAJOR The REGDOC should not apply to Research and Development (R&D) facilities, which can differ greatly from CANDU reactors and rely on different safety measures. This is particularly important where risks from fuel failure are much lower, and additional requirements are not warranted. For example, the Zero Energy Deuterium research reactor (ZED-2) is a zero energy reactor and it is operated at atmospheric pressure. The source term is much lower than a CANDU station. The release from accident scenarios are very benign when compared to the power reactors that are driving this REGDOC. The ZED-2 reactor performs fuel testing and qualification activities. Requiring enhanced fuel testing and qualification for a reactor that is used for this purpose creates circular and unachievable requirements. ZED-2 and the Recycle Fuel Fabrication Laboratories (RFFL) are used for innovation of new and/or improved technologies; additional requirements for licensing fuel will inhibit the ability of R&D programs	Include in this section a statement that the REGDOC is not applicable to non-power reactor facilities; alternatively that it is to be used only as a guideline for non-power reactor facilities.	For facilities where the risk of fuel failure has been assessed to be much lower than CANDU reactors (e.g., research reactors), the application of the same requirements would increase regulatory burden with no improvement on nuclear safety. It would also hinder the use of research facilities for testing and qualifying fuel, and supporting innovation of new/improved technologies.	REGDOCs are only applicable if included the licensing basis of the facility, such as referenced in the LCH. In applying any REGDOC, the graded approach is used. REGDOC-, 2.4.5 does not apply to research reactors.

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
			to use such facilities to address industry needs in a timely manner.			
8.	OPG, Bruce Power, NB Power, CNL, CNA	Section 1.2	Clarification "*This document focuses on fuel design, operation, monitoring and safety assessments for operating facilities*". Similar to comment # 2, the document covers much more than its cover page title and preface denotes.	Separate the document into its constituent parts consistent with the Safety Control Areas 3 – Operating Performance, 4 – Safety Analysis, 5 – Physical Design, 6 – Fitness for Service, 7 – Radiation Protection, 9 – Environmental Protection, 11 – Waste Management, 12 – Security, 12- Safeguards and Non-proliferation , 14 – Packaging and Transport, 15.9 Criticality Program		See the response to comment 3
9.	OPG, Bruce Power, NB Power, CNL, CNA	Section 1.2	MAJOR "*This document will be reviewed as appropriate to incorporate operating experience (OPEX) with new reactor technologies*" Has the Regulatory document been assessed against operating stations and has each facility been shown to be fully complaint? If not, you'd expect OPEX would point this out. If so, the OPEX review should be included to assist users in their use and review of the document. If OPEX has shown operating stations would have not had issues meeting this document historically then the document isn't needed for operating stations.	Are operating stations going to radically change their fuel designs, such that this document is needed? If not, consider its purpose and value. Consider whether this should be for new licensed facilities only.	This document has impacts on the mature CANDU fuel designs. There is no benefit to applying this document to mature fuel design which has clearly defined and CNSC approved requirements. This document should focus on new fuel designs. The Industry has implemented many successful design changes and change control processes over the last many years which have been approved by the CNSC.	Current CANDU power plants are C fully compliant with the requirements in the draft REGDOC. Regulatory clarity and formalizing our expectations has an intrinsic value. This document captures the corporate knowledge and regulatory positions on the topic over decades in a single location.
10.	OPG, Bruce Power, NB Power, CNL, CNA	Section 1.2	Clarification " *While this document focuses on CANDU fuel, high-level concepts within it may apply to other technologies…"high-level safety concepts*" "May apply" is very unclear. The high-level safety concepts are not specifically identified. The word "concepts" only arises in this subsection.	Ensure the clause is clearer for the non-CANDU fuel user. Identify which are the high-level safety concepts by at least referring to the specific sub-clauses.		Clarity added through references to: the design and qualification process, the documentation of design, operational requirements and the need for monitoring and inspection of fuel.
11.	OPG, Bruce Power, NB Power, CNL, CNA	Section 1.4	Clarification "*The following standards are relevant to this regulatory document….Management … QA, …. Design*" None of the references includes Nuclear Safety Analysis. The focus seems to be on design of new fuel systems, procurement, QA, and management.	Refocus the document as a Design document and specifically as a new plant fuel design document.		See the response to comment
12.	OPG, Bruce Power, NB	Section 2 & Appendix A:	Clarification	Clarify intent and remove the reference to REGDOC-2.5.2, *Design of Reactor Facilities*.		TRerence to DiD is provided as an example and there is no need for current facilities to change

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
	Power, CNL, CNA		"*the first two of five physical barriers to the release of radioactive material are the fuel matrix and the fuel cladding. The primary heat transport system, the containment, and the exclusion zone constitute the other three physical barriers*." These physical barriers are not the same as the Defence in Depth (DiD) levels espoused in REGDOC-2.5.2, *Design of Reactor Facilities* and referenced in REGDOC-2.4.1, *Deterministic Safety Analysis*. Is this meant to be a recognition that REGDOC-2.4.1, *Deterministic Safety Analysis* DiD barriers for operating stations are not the same as those for future facilities?			existing practices. DiD is stated to protect the barriers which are listed, there is no contradiction. Appendix A has been removed.
13.	OPG, Bruce Power, NB Power, CNL, CNA	Section 2 and Appendix A	Clarification Section 2 identifies 5 layers of Defence in Depth when determining nuclear fuel safety in water-cooled reactors. This is slightly contradicted by the Appendix A, which credits the layers differently, and also indicates that Level 5 doesn't apply to nuclear fuel safety.	Clarify if the five physical barriers are the same as the five levels of Defence in Depth, and if Level 5 applies or it doesn't.		Levels of DiD and physical barriers are not the same. Refer to International Nuclear Safety Advisory Group (INSAG)-10, *Defence in Depth in Nuclear Safety*.
14.	OPG, Bruce Power, NB Power, CNL, CNA	Section 2	Clarification This section discusses Defence In Depth (DiD) applicable to fuel. There is another section on the topic of DiD (Section 4.3 Defence in Depth). Section 4.3 is a more appropriate place to discuss the application of DiD to fuel design.	It is suggested to incorporate the information presented in Section 2 into subsection 4.3 and remove it from Section 2 (or only mention it briefly). Having said this, this section can fulfill an important role of defining the ultimate goal of fuel safety (say, to retain all radionuclides within the fuel system or to limit releases below established acceptable levels for all design-basis plant states), and provide discussion on fuel safety criteria.		Section 2 has been reworked to provide a broader overview of the fundamental safety functions as they relate to nuclear fuel safety.
15.	OPG, Bruce Power, NB Power, CNL, CNA	Section 2	Clarification "*Defence-in-Depth …*" This is the only section which talks about Safety while the document is called: "Safety Analysis Nuclear Fuel Safety" It appears that other Safety Analysis requirements are captured in REGDOC-2.4.1, *Deterministic Safety Analysis*; there is no need to be repeat them in this document. The only aspect covered under Nuclear Safety in this document is DiD and the levels of DiD are not consistent with the REGDOC-2.4.1, *Deterministic*	Change the title of this REGDOC; focus on a Fuel Design and Qualification requirement document. If one or two items are missing from REGDOC-2.4.1, *Deterministic Safety Analysis* add those to the revision of REGDOC-2.4.1, *Deterministic Safety Analysis*.		Fuel and fuel design is a cross cutting subject which impacts, safety analysis, operations and design. Fuel does not fit perfectly into any one SCA. However, REGDOC, 2.4.5 brings regulatory clarity by consolidating all the fuel design requirements into one document. REGDOCs in associated SCAs will point to REGDOC-2.4.5.

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

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			Safety Analysis or REGDOC-2.5.2, *Design of Reactor Facilities*, thus it appears this document is trying to correct mistakes in those documents since the original design basis from the Siting Guide and AECB-1059 covered the five levels discussed in this document.			
16.	OPG, Bruce Power, NB Power, CNL, CNA	Section 3. (Preamble)	Clarification The preamble is basically a repeat of the following requirements section.	Eliminate (or reword) text.		The intent of the preamble is to give background and context to the requirements and guidance. There is no duplication or repetition of the requirements.
17.	OPG, Bruce Power, NB Power, CNL, CNA	Section 3. Requirements	Clarification The requirements seem to be repeated in more detail in Section 3.1.	Eliminate redundant requirements.		The initial text of each section is a high level introduction to the objectives of the section, then the subsections provide the details.
18.	OPG, Bruce Power, NB Power, CNL, CNA	Section 3. Requirements #4	Clarification All five levels of DiD are not applicable as per Appendix A. Explicit limits for Level 4 DiD are problematic, as correctly discussed in Appendix A.	Revise to: "*within its safety limits at all applicable levels of DiD, where each safety limit is explicitly taken into account in the fuel design basis, where practicable*."		Change made to wording to address the concern, specifically that this applies to "the applicable levels of DiD"
19.	OPG, Bruce Power, NB Power, CNL, CNA	Sections 3.1, 3.5, 5	MAJOR The document frequently refers to fuel qualification; however, it could benefit from defining the term on first occurrence and in the Glossary. Section 5 is an important section especially for advanced reactor designs. The "fuel qualification process" is not explicitly described in regulatory documents, but frequently alluded to.	For newer designs, consider: Adopting or adapting definitions from US NRC NUREG-2246 Fuel Qualification for Advanced Reactors for "Qualified fuel" and "Fuel qualification". Also for the benefit of new advanced reactor designs, consider adding relevant subsection on regulatory basis and the assessment framework for fuel qualification similar to the joint US NRC – CNSC reports concerning Tristructural Isotropic (TRISO) Fuel Qualification) and NUREG-2246 - Fuel Qualification for Advanced Reactors. It would also be beneficial to add a systematic and holistic outline of fuel qualification goals and requirements.	The definition for fuel qualification and the requirements for a fuel qualification process are being discussed within industry and it would be a benefit to have these defined for the Canadian nuclear regulatory space.	Agree with the addition of the definitions for fuel qualification and qualified fuel from NUREG-2246. CNSC's has a non-prescriptive approach to fuel and fuelk design requirements. The general approach proposed is qualification demonstrates the fuel meets the requirements defined during the design process. Being more prescriptive may actually be a detriment to more unique fuel designs. While added guidance is always desirable, we don't feel that it needs to be in this specific document. Licensees are free to use documents such as NUREG-2246 to demonstrate they meet the high level goals and requirements.
20.	OPG, Bruce Power, NB Power, CNL, CNA	Sections 3, 3.1, 3.2	MAJOR It states a fuel design program is required. However, programs have a very specific meaning within each licensee's management system, and the new program described may not meet the licensee's requirements. Fuel Design would be captured by the Engineering Change Control (ECC) process.	Revise. Don't over prescribe requirements for new programs. Instead, state the "high-level" performance requirements and let the industry demonstrate compliance. This should apply to new fuel designs only.	Adding new administrative requirements without any added benefit to nuclear safety.	Agree. The wording has been changed to remove reference to a program, instead using programmatic measures. The requirements have been retained.
21.	OPG, Bruce Power, NB Power, CNL, CNA	Section 3.3	Clarification CSA N286-12, *Management system requirements for nuclear facilities* and CSA N299.1, *Quality assurance program requirements for the supply of items and*	Remove redundancy.		Section 3.2 and 3.3 have been merged together. Section 3.3 has been moved to guidance. 3.2 requires that the fuel program be managed and the guidance now points to CSA N286:12, *Management System Requirements for Nuclear*

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			services for nuclear power plants, Category 1 are already requirements for Bruce Power. They don't have to be repeated here.			*Facilities* and CSA N299.1 series, *Quality Assurance Program Requirements for the Supply of Items and Services for Nuclear Power Plants* as the preferred method to demonstrate compliance. As such we do not believe this is redundancy.
22.	OPG, Bruce Power, NB Power, CNL, CNA	Sections 3, 4, 4.5	Clarification "*...the fuel design is properly qualified for the subset of all facility states...*" Was "facility states" used instead of "plant states" to apply to a broader class beyond nuclear power plants? Use of plant states would be consistent with REGDOC-2.5.2, *Design of Reactor Facilities* and REGDOC-3.6, *Glossary of CNSC Terminology*. If facility states is distinct and intentional suggest to define at the first occurrence and in the Glossary.	Replace with "plant states" or define "facility states".		Yes facility states was used in place of plant states and there is an intention to update the glossary to address this.
23.	OPG, Bruce Power, NB Power, CNL, CNA	Section 3.5	Clarification Bullet 1: Could benefit from expanding on requirements for "*establishing a knowledge base*".	Revise to: "*establishing a fuel design knowledge base that allows the licensee to understand and predict fuel behaviour for all plant operating states with established uncertainties*"		Agreed. Suggested text incorporated.
24.	OPG, Bruce Power, NB Power, CNL, CNA	Section 4	Clarification The sequence of subsections would make more sense if subsections 4.7 Design requirements and 4.8 Design safety objectives are the first two subsections. The two steps of the design process described in these subsections set the stage for the reminder of the design process.	Reorder section. Sections 4.1 Notification and 4.2 Design change are better placed later in Section 4, after the subsection "Degradation mechanisms".		Section 4 reordered consistent with comment.
25.	OPG, Bruce Power, NB Power, CNL, CNA	Sections 4.1, 4.2	MAJOR Any changes to fuel design, specification or manufacturing methods would be covered by licence conditions, e.g. G.1 Licensing Basis for the Licensed Activities and G.2 Notifications of Changes. This is a duplicate requirement.	Remove any requirements that are defined in other REGDOCs.	Adding new administrative requirements without any added benefit to nuclear safety.	G.1 and G.2 are very broadly defined. 4.1 was added with the intent to remove similar text in some LCHs when this REGDOC is added. 4.2 is to clearly articulate that G.1 applies.
26.	OPG, Bruce Power, NB Power, CNL, CNA	Section 4.3	Clarification "*For the fuel design process, the licensee shall take into account the core principles of level 1 DiD (see appendix A), through...9. due consideration of site characteristics*." Suggest to expand 9 to "*due consideration of facility design parameters and site characteristics.*" (definition of bounding envelope from REGDOC-3.6, *Glossary of CNSC Terminology*).	Revise definition to be consistent with REGDOC-3.6, *Glossary of CNSC Terminology*.		Agreed, change made.

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

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27.	OPG, Bruce Power, NB Power, CNL, CNA	Section 4.3	MAJOR DiD is duplicated from REGDOC-3.5.3, *Regulatory Fundamentals*.	Just reference REGDOC-3.5.3, *Regulatory Fundamentals*, instead of making it another requirement.	Adding new administrative requirements without any added benefit to nuclear safety.	REGDOC 3.5.3, *Regulatory Fundamentals* is referenced in operating stations LCHs for the purpose of describing the licensing basis. While REGDOC 3.5.3, *Regulatory Fundamentals* does have text on defence in depth it is not referenced in the LCH in the context of design or safety analysis. Thus its inclusion in section 4.3 is a duplication of requirements on licensees.
28.	OPG, Bruce Power, NB Power, CNL, CNA	Section 4.3 Bullets 5 & 8	Clarification The list is more of "guidance" rather than "requirements" while the latter need to be defined with rigor and criteria.	Revise to "Guidance".		Agreed. The methods of achieving level 1 DiD have been moved to guidance but the requirement to take level 1 DiD into account has remained as a requirement.
29.	OPG, Bruce Power, NB Power, CNL, CNA	Section 4.4	Clarification Regarding "*confirmatory analytical activities*", suggest including this is to be supported by experimental testing and qualification, not by analytical approaches only.	Revise to: *"The licensee shall commence safety analysis at an early point in the fuel design process, with iterations between design activities and confirmatory analytical activities, supported by experimental and qualification testing."*		Agreed
30.	OPG, Bruce Power, NB Power, CNL, CNA	4.4 Safety Analysis – Requirements	Clarification Second sentence of this requirement should be guidance pertaining to the first sentence. Specific SSR-2/1 clauses are not provided, making the applicability of this IAEA document ambiguous (e.g., are all clauses of SSR-2/1 required under this document?).	Make this sentence Guidance and not a Requirement: "*The objective is the demonstration of an increase in scope and level of detail as the design process progresses in accordance with IAEA SSR-2/1: Safety of Nuclear Power Plants: Design [3].*"		Agreed
31.	OPG, Bruce Power, NB Power, CNL, CNA	Section 4.6	Clarification Suggest changing bullet 5 to "waste management, storage and minimisation".	Revise to: "waste management, storage and minimisation".		Agreed. While waste management as a whole is out of scope of the REGDOC, consideration of the fuel's design on this area is not.
32.	OPG, Bruce Power, NB Power, CNL, CNA	Section 4.7	Clarification "*As part of the fuel design process, the licensee shall identify: 1. functional requirements; 2. performance requirements;*" Although commonly understood suggest to define in Glossary as not defined in this document or REGDOC-3.6, *Glossary of CNSC Terminology*. Could adopt/adapt definitions from Systems Engineering Fundamentals referenced in Additional Information.	Add definition.		Definitions have been added to the glossary section of the REGDOC which will then be imported into REGDOC 3.6, *Glossary of CNSC Terminology*. The definition for functional requirements was adopted from the IAEA definition, where as the performance requirements definition was adopted from NUREG 2246.
33.	OPG, Bruce Power, NB Power, CNL, CNA	Section 4.8 item 1b	Clarification "*fuel pellet, element and bundle dimensions will remain within operational tolerances described in TECDOC No 1926…*" This TECDOC does not describe operational tolerances.	Suggest clarifying if this guidance item is referring to a specific set of criteria within the TECDOC as it pertains to operational tolerances.		Reference removed.

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

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34.	OPG, Bruce Power, NB Power, CNL, CNA	Section 4.8 item 2b	Clarification *"For accident conditions considered in the safety report"* *Demonstration of "minimum"* as a design objective may not be achievable in all circumstances. Zero failures is the actual minimum number of failures, which is not achievable for all accident conditions, considered in the safety report. The safety report includes both Design Basis Accidents and Beyond Design Basis Accidents. An ALARA approach may be more appropriate, i.e., fuel sheath failures shall be as low as reasonably achievable.	Clarify if this guidance is intended to apply to both DBA and BDBA?		Agreed. Text modified to "fuel sheath failures will be kept ALARA". Text also clarified that section 2 is for DBA events.
35.	OPG, Bruce Power, NB Power, CNL, CNA	Section 4.8 item 2a & Section 9	MAJOR *"the fuel elements will not fail"* Some Anticipated Operational Occurrences (AOO) may involve failure of the sheath, e.g., if the AOO involves debris in the heat transport system. Per REGDOC 2.4.1, *Deterministic Safety Analysis* Section 4.3.2 the AOO acceptance criterion is 0.5 mSv (dose to public). This allows for some fuel failures (or pre-accident fuel defects) for more severe AOOs, as long as the dose acceptance criteria can be shown to be met. Preclusion of fuel failures, however, may be used as a derived acceptance criterion for many if not most AOOs. Qualifiers in these sections are warranted.	Remove: *"the fuel elements will not fail"* Revise to: "*fuel damage or degradation during AOO does not invalidate safety analysis assumptions*" or some such statement.	Establishing a requirement that fuel failure is precluded for all AOOs, including the most severe AOOs, may be equivalent to changing the AOO dose limit in REGDOC-2.4.1, *Deterministic Safety Analysis* to zero.	Suggested change partially adopted. The guidance statements are for both normal operations and AOOs. Thus the text "during AOO" was not adopted.
36.	OPG, Bruce Power, NB Power, CNL, CNA	Section 4.8 item 2c	Clarification *"the fuel assembly and its component parts will remain in position…"* In some accidents such SBLOCA/LBLOCA, the fuel string will move following reverse flow. So the fuel will not remain in position unless the definition of "position" means inside the channel. For DBAs is it not necessary for fuel to remain in position; effective cooling of the fuel bundle is important irrespective of its position or relocation.	Clarify whether "position" means inside the channel?		Text updated to make it clear the intent is that the fuel remains in "a position" that does not prevent effective core cooling.

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
37.	OPG, Bruce Power, NB Power, CNL, CNA	Section 4.9	Clarification *"Fuel degradation mechanisms and associated limits that may challenge the fuel design."* In this context, does "limits" refer to design limits associated with the fuel design itself or operating limits associated with the use of the fuel design? For example, Section 3.1 refers to "fuel design and fuel design limits". Are these the same limits?	Suggest clarifying if limits are design limits, licence limits, operating limits, or something else; this suggestion applies throughout the draft REGDOC.		Clarified that these limits are the performance limits imposed by the degradation mechanisms.
38.	OPG, Bruce Power, NB Power, CNL, CNA	Section 4.9 item 5	Clarification What constitutes an "*a verified and auditable knowledge base*" in the bullet *"… fuel damage and failure mechanisms and associated limits shall reflect a verified and auditable knowledge base."*	Unclear, clarification required.		Verified knowledge base and auditable knowledge base definitions have been added to the glossary.
39.	OPG, Bruce Power, NB Power, CNL, CNA	Section 5.2	Clarification *"demonstrates the adequacy of"* may lead to a situation of undefined level of *"adequacy"* or undefined methodology for *"demonstration"*.	Need clear acceptance criteria and process guideline.		Guidance has been added to address this issue.
40.	OPG, Bruce Power, NB Power, CNL, CNA	Section 5.3	MAJOR This is a repeat of other clauses and requirements. No value added.	Remove requirements on management system and quality assurance.	Adding new administrative requirements without any added benefit to nuclear safety.	The wording has been modified to account for the qualification being performed by an organization that is not the operator. The requirement. Does not add additional regulastory burden..
41.	OPG, Bruce Power, NB Power, CNL, CNA	Section 6	MAJOR This seems a repeat of the Engineering Change Control process /licence conditions G1 & G2 requirements.	Remove or refer to the licence.	Adding new administrative requirements without any added benefit to nuclear safety.	Section 6 is consistent with the past practice for all recent fuel designs used in Canada and the expectations currently in licensee LCHs. The Fuel design is not consistently or clearly specified within the written notification documents or the licensing basis and thus the text clarifies the need to submit the specified information for review. The section improves regulatory clarity.
42.	OPG, Bruce Power, NB Power, CNL, CNA	Section 6 lead in paragraph	Clarification Is the following paragraph intended to refer to the loading of bundles associated with a Demonstration Irradiation (DI) as well? *"Before loading a new or modified fuel design into a reactor core, the licensee shall submit, to the CNSC, the following information and obtain CNSC staff's confirmation that the design is within the licensing basis and is qualified for use…"*	Unclear, clarification required if DI is included. If so, then revise to include a note indicating the graded approach can be applied.		Text in the guidance has been added to address this comment.
43.	OPG, Bruce Power, NB Power, CNL, CNA	Section 7	Clarification Typically, FFS is used in the presence of a defect or flaw in the fuel, in the presence of a degradation	Add additional information within the body of the document on the two essential aspects of fuel FFS which are 1) understanding fuel and fuel bundle degradation mechanisms to the extent that		Guidance added to section 7.3 to clarify that Fitness For Service (FFS) assessments should be performed to understand degradations mechanisms and rates. Section 8 adequately

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
			mechanism or for anticipated degradation mechanisms. For example, thinning of sheath wall thickness due to corrosion or fretting wear can be anticipated and included at the design stage as a FFS criteria. FFS assessments and established FFS criteria justify the safe operation of the plant (i.e., defect or flaw will not grow to an unacceptable size, the rate of the degradation mechanism is monitored and assessed to be acceptable) until the next plant outage.	degradation rate(s) is predictable and 2) having monitoring systems in place that enable monitoring the rate(s) of degradation(s). These aspects are not explained well in this section although there are two unreferenced Appendices B and C included in the report related to failure and degradation mechanisms. Appendix D is also not referenced in main body either.		covers the need to perform monitoring of the fuel condition and associated degradation rates.
44.	OPG, Bruce Power, NB Power, CNL, CNA	Section 7	Clarification *"…fuel parameters to remain within the initial conditions assumed by the Safety Analysis Report…"* The various analyses in the safety report (physics, thermal hydraulics, fuel performance, etc.) use different models of the fuel bundle, some more detailed than others. The initial conditions for the fuel bundle assumed by these different analyses can vary as appropriate for the specific analysis, and may not translate to parameters the fuel bundle can be confirmed to be within during operation.	Suggest rewording as *"…fuel parameters to remain consistent with the initial conditions assumed by the Safety Analysis Report…"*		Agreed. Wording updated
45.	OPG, Bruce Power, NB Power, CNL, CNA	Section 7.1 & 7.2	Clarification FFS criteria are dispersed throughout various documents and sometimes stated implicitly. This is considered acceptable for an operating plant with extensive operational history.	Add clarity to the guidance section that FFS criteria can be stated implicitly. Also consider adding clarity regarding approaches to establishing FFS criteria to the guidance section (e.g., graded approach and risk-informed decision making).		Section 7.1 considers that the full documentation of the FFS criteria may not be practical as it must be stated implicitly. This is realized by the text "to the extent practicable". There is no specific requirement for a single document consolidating the FFS criteria. , Criteria dispersed in various licensee documents is acceptable provided a "roadmap" is provided as to where ere in their documents the requirements were located.
46.	OPG, Bruce Power, NB Power, CNL, CNA	Section 7.1 item 5	Clarification *"requirements for return to service after an accident."* It is not clear if "accident" includes AOOs or is only DBAs. Fuel return to service is not an acceptance criterion applied to DBAs.	Suggest rewording as "*requirements for return to service after an AOO*."		Intent was that return to service would be after an AOO or DBA. Text updated to clarify this.
47.	OPG, Bruce Power, NB Power, CNL, CNA	Section 7.3	Clarification The need to perform fuel FFS assessments is expected to be rare and the usefulness of having an explicit FFS criteria and FFS governance is questionable.	Make this part guidance only.		The need for fuel FFS assessments should be infrequent. This section requires that the licensee have triggers for when assessments are needed. The process to assess fuel FFS does not need to be unique, but understood to be adequate for the objective.
48.	OPG, Bruce Power, NB Power, CNL, CNA	Section 7.4	Clarification Undefined term "*assessed fuel condition*".	Include clarification on the term "assessed fuel condition" and when it applies.		Details added to clarify that records should be kept that detail the fuel condition using available data and assessments.

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

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49.	OPG, Bruce Power, NB Power, CNL, CNA	Section 8 2nd Paragraph	Clarification "*Monitoring and fuel inspection activities play an important role in ensuring the License's acceptable safety performance in a number of safety and control areas (SCA's), including operating performance, physical design, safety analysis and waste management*.". This is the first mention of waste management in the document. There is no guidance concerning waste management in the design portion of the document. Will waste requirements require any change to the fuel design (for instance cladding material specifications, are there any particular test requirements for the fuel due to waste requirements, and are there non-destructive tests required during the manufacturing phase to ensure fuel integrity when transferred to waste?	Consider adding information on the identified issues to appropriate sections of the REGDOC.		Waste management has been removed from the scope of the document and thus the associated text has been removed.
50.	OPG, Bruce Power, NB Power, CNL, CNA	Section 8.1	Clarification *"The licensee shall establish a monitoring and inspection program that ensures that the fuel is fit for service."* Is above reference to a monitoring and inspection program referring to both fresh fuel and irradiated fuel monitoring/inspections? If yes, then as written the sentence is lacking information since it only refers to fitness for service and fitness for service applies to fuel that will be irradiated or is in the process of being irradiated. Once a bundle is irradiated and discharged to the fuel bay, being fit ceases to be a hard requirement; unless, "fit" in this context means something more than "fit for in-core operation".	Unclear, clarification required.		Additional guidance and clarification on the scope of the requirements has been added.
51.	OPG, Bruce Power, NB Power, CNL, CNA	Section 8.2 Bullet 1	Clarification For existing power plant facilities, technicians complete fuel inspection training at Stern labs; however, there are no formal qualifications for fuel inspection or associated training at this time.	Clarify what is "qualified personnel" and the requirements will be defined by the licensee's training program and management system.		Text in 8.2 changed to require that the personnel be trained.
52.	OPG, Bruce Power, NB Power, CNL, CNA	Section 8.2	Clarification "*The licensee shall ensure that the monitoring and inspection program includes onsite and in-bay*	Remove reference to: "…hot-cell examinations."		If hot cell examinations are not necessary for providing needed monitoring and oversight of the fuel then there is no need for a licensee to ensure hot-cells are commercially available. Alternate

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
			inspections of fresh and irradiated fuel and, if necessary, hot-cell examinations." This seems to imply that power plants will be responsible, at least partially, for assisting labs in maintaining their hot cells and PIE capabilities.			methods can be employed. Therefore, if necessary" is an adequate qualifier.
53.	OPG, Bruce Power, NB Power, CNL, CNA	Section 8.4	Clarification If the document is to cover Class Ib reactor facilities the appropriate reporting requirements should be referenced.	Include a reference to 'REGDOC-3.1.2, Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills", which would be applicable to research reactors.		Class 1b facilities are outside the scope of the document..
54.	OPG, Bruce Power, NB Power, CNL, CNA	Section 8.8	Clarification "*For CANDU reactors, the minimum number of in-bay inspections for a normally operating reactor with no identified active degradation mechanisms is 20 bundles per year per reactor*" Would it be possible to refine the language of this requirement so that the utilities are free to prorate downward the inspection numbers for years with outages of significant length? Additionally, when a reactor is newly fueled (either a new reactor or a reactor recently refurbished) no fuel will be discharged for at least 90 days or longer. Would it be possible to refine the language of this requirement so that this reality is acknowledged and the utility can accommodate this operational phase in its fuel inspection numbers?	Revise wording to allow for licensees the flexibility to determine appropriate number of fuel inspections to accommodate the operational phase.		In the requirements section, the wording has been updated to "20 bundles per normal operating year per reactor". Guidance has been included to explain normal operating year and give the ability to prorate the inspection requirement for long outages and refurbishment activities.
55.	OPG, Bruce Power, NB Power, CNL, CNA	Section 8.10	Clarification "*The licensee shall minimize failed fuel residency times, as fission product release into the coolant and its deposition on the primary heat transport system piping may result in higher worker doses*." Note, that current US BWR fleet practices for small fuel failures are to detect failure, identify failed fuel cell, mitigate continued fuel degradation and reduce FP release via power suppression; replace fuel at next planned outage.	Suggest using similar verbiage from Section 8.8 Inspection "*For reactors of other designs, the licensee shall seek acceptance from CNSC staff on...*"		The first paragraph is in line with the text from the US Boiling Water Reactor (BWR) fleet and Canadian practices. The following two paragraphs have been moved into guidance.
56.	OPG, Bruce Power, NB Power, CNL, CNA	Section 8.10	Clarification What does immediately mean in the context of removing failed fuel? It usually takes a few days to remove failed fuel after it has been located.	Unclear, clarification required.		to the REGDOC does not set an exact time frame, but indicates that if failed fuel cannot be removed immediately, some time delay is acceptable. However, excessive delays would not be acceptable. The timeframe of what an excessive delay would be dependant on the reactor

<u>Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*</u>

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
						technology. Therefore, the wording has been changed to 'in a timely manner' .
57.	OPG, Bruce Power, NB Power, CNL, CNA	Section 7.3	Clarification Guidance section duplicates REGDOC-2.4.1, *Deterministic Safety Analysis*	Remove duplication.		REGDOC 2.4.1, *Deterministic Safety Analysis* is applicable to deterministic safety analysis. Fuel FFS assessments do not need to explicitly follow REGDOC 2.4.1, *Deterministic Safety Analysis*. Thus the guidance indicating that codes used for FFS assessment should be compliant with N286.7, *Quality assurance of analytical, scientific, and design computer programs* is not a duplication.
58.	OPG, Bruce Power, NB Power, CNL, CNA	Section 8.10 last sentence	Clarification The wording could be changed to highlight the intent of applying the ALARA principle is to minimize dose to personnel being assigned to failed fuel detection and removal; **<u>not</u>** to keep the financial cost of assigning such personnel low, as one could erroneously infer with the current wording.	Revise to: "*The licensee shall apply the principle of ALARA (as low as reasonably achievable) when determining the resources and efforts being put towards failed fuel detection and removal. <u>Radiation doses received by personnel consequent to such efforts shall be kept ALARA</u>.*"		Agreed.
59.	OPG, Bruce Power, NB Power, CNL, CNA	Section 9	Clarification "*When used in conjunction with the operations program, the fuel program shall ensure that fuel is operated within its design and operating envelope.* *In conjunction, these programs set operational limits and conditions (OLCs) to ensure that fuel is not damaged….fuel remains with the design and qualification envelope*." REGDOC-2.4.1, *Deterministic Safety Analysis* clauses 4.1, 4.4.2.5, 4.5, 4.6.1 already include the need to consider operating limits and permitted operational states.	Remove this section; consider what is missing from REGDOC-2.4.1, *Deterministic Safety Analysis* and add those to the next revision of REGDOC-2.4.1, *Deterministic Safety Analysis*.		The safety analysis does not explicitly consider fuel condition. It assumes the fuel is pristine. So inclusion of fuel design and operating envelope considerations in 2.4.1 would not fit. Ideally these requirements should be in the CSA standard for safe operating envelope, but N290.15, *Requirements for the safe operating envelope of nuclear power plants* explicitly excludes parameters not controllable by control room operators. Thus fuel is excluded. Section 9 was developed to close this gap without a large scale shift in the philosophy of either of the other two documents.
60.	OPG, Bruce Power, NB Power, CNL, CNA	Section 9.1	Clarification *'Fuel OLCs shall have the largest safety margins practicable'*. The word *practicable* is subjective.	Revise to remove subjectivity.		Agree. Statement has been removed.
61.	OPG, Bruce Power, NB Power, CNL, CNA	Section 9.2	Clarification Guidance is required to address existing plants that are licensed on different criteria; i.e., probability-based initiating events like the current AOO regime of REGDOC-2.4.1, *Deterministic Safety Analysis*, and use of graded approach to establish REGDOC-2.4.1, *Deterministic Safety Analysis* compliance.	Guidance required to address existing stations with legacy analyses regarding fuel FFS and AOOs.		Wording in section 9.2 has been modified to reference section 7.1 on fitness for service and the qualifier "to the extent practicable" has been repeated again in section 9.2.

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
			Not all AOOs affecting fuel are addressed by safety analysis to the extent that explicit FFS criteria can be developed.			
62.	OPG, Bruce Power, NB Power, CNL, CNA	Section 9.3	Clarification "*The operational modes for normal operating conditions should include:...*" Suggest using the term "operating configurations" to align with REGDOC-2.5.2, *Design of Reactor Facilities* as well as to align with the configuration definitions listed in REGDOC-2.5.2, *Design of Reactor Facilities* Version 2 Section 5.3.1 Normal Operation.	Revise to align with REGDOC-2.5.2, *Design of Reactor Facilities*.		Agreed. Wording updated in 9.3 to be more consistent with REGDOC-2.5.2, *Design of Reactor Facilities*.
63.	OPG, Bruce Power, NB Power, CNL, CNA	Section 9.3	Clarification What do transitional states mean? How is life extension different to refurbishment? How is maintenance/outage different to shut down? In the guidance, why are heat transport (HT) pressure tests mentioned? This is for HT requirements, not fuel requirements.	Provide more information on operational modes. Remove reference to PHTS pressure tests.		Text added to define transitional states. Life extension and refurbishment moved to the same line to imply they are similar, but life extension has been kept as one Canadian licensee is avoiding using the term 'refurbishment', The guidance has been modified to indicate that testing where fuel will be present in core even if it is not the primary focus of the test.
64.	OPG, Bruce Power, NB Power, CNL, CNA	Section 9.5	Clarification "*The licensee shall take into account the impact of aging of the PHTS*" This is already covered in REGDOC-2.4.1, *Deterministic Safety Analysis* clauses 3.2, 4.4.3.	Given it is already covered by REGDOC-2.4.1, *Deterministic Safety Analysis*, remove the clause.		This section pertains to fuel Operational limits and conditions (OLCs) for normal and abnormal operations and is not fully covered by 2.4.1, *Deterministic Safety Analysis* as it does not cover normal operations. Thus this section needs to remain.
65.	OPG, Bruce Power, NB Power, CNL, CNA	Appendix A	Clarification Appendix A is a duplicate of REGDOC-3.5.3, *Regulatory Fundamentals*, so it doesn't need to be included.	Reference REGDOC-3.5.3, *Regulatory Fundamentals*, instead of making it another requirement.		Appendix A has been removed from the REGDOC
66.	OPG, Bruce Power, NB Power, CNL, CNA	Appendix A	Clarification "*Level 3 & 4 DiD is achieved by having documented and understood failure mechanisms and safety criteria in conjunction with a robust fuel deisgn, such that if a design basis accident did occur, the fuel behaviour would be understood and the barrier protected as per the fuel design basis…. For beyond DBAs … to the extent practicable*" Appears to be a large expansion of documentation for Analysis Reports.	Clarify this would not apply to the already licensed fuel designs.		Appendix A has been removed.
67.	OPG, Bruce Power, NB	Appendix A	Clarification	Statements must be aligned.		Appendix A has been removed.

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
	Power, CNL, CNA		Discrepancy on the applicability of the DID Level 5 to fuel safety between Appendix A and Section 2.			
68.	OPG, Bruce Power, NB Power, CNL, CNA	Appendix A, Level 2 DiD	Clarification The FFS limits like those for failure mechanisms in Level 3 DiD, are functions of bundle design, composition, testing and code/knowledge base to support simulation of those figures of merit. Level 2 DiD FFS criteria are the same but tied to damage mechanisms. Safety analysis demonstrates the criteria are met, but the criteria aren't necessarily designed to support safety analysis for either DiD level. Safety analysis instead demonstrates that established FFS requirements are met for applicable Level 2 DiD assessed AOO events.	Add clarifying statements after "*Level 2 DiD is achieved by having appropriate fitness for service limits to support level-2 deterministic safety analysis.*" to address comment.		Appendix A has been removed.
69.	OPG, Bruce Power, NB Power, CNL, CNA	Appendix B - D	Clarification No reference is made in the text to Appendices B, C or D.	Make reference to these appendices in the body text.		Reference have been included in section 4.9
70.	OPG, Bruce Power, NB Power, CNL, CNA	Appendix B	Clarification Missing degradation mechanisms.	Add to table: 1. Under "*Deformation with Material Loss*", add "*Endplate Wear*" to "*Observable effect*" column. 2. Under "*Change in Material Properties*", add "*Oxide or crud depositions*" to "*Observable effect*" column.		Rows added to Appendix B as suggested
71.	OPG, Bruce Power, NB Power, CNL, CNA	Appendix B	Clarification Excessive fuel deposits should be added to the table; key influencing parameter would be coolant chemistry; impact relevant to safety would be heat transfer and sheath thinning.	Add *excessive fuel deposits* to table.		Excessive fuel deposits and oxide or crud deposits have been merged into one section.
72.	OPG, Bruce Power, NB Power, CNL, CNA	Appendixes B, C , D	Clarification Appendixes B, C, and D are very CANDU-centric.	Should include information and examples for other reactor fuels.		This REGDOC recognizes that CNSC and Canadian experience is primarily with CANDU reactors. Thus much of the more detailed guidance and examples in the REGDOC are naturally CANDU centric. The appendices should be relatively applicable to water cooled reactors. These appendices are intended to be additional information and are not requirements.
73.	OPG, Bruce Power, NB Power, CNL, CNA	Appendix C	Clarification Excessive fuel deposition should be added to the table.	Add *excessive fuel deposition* to list.		Agreed. Excessive fuel deposits has been added to appendix C.
74.	OPG, Bruce Power, NB Power, CNL, CNA	Appendix C	Clarification Fuel degradation mechanisms under AOO conditions should include all of those from Appendix B. For example, fuel stuck in crossflow may be considered an	Consider eliminating this Appendix and identifying Appendix B as (possibly) applicable to AOOs.		Agree. Appendix C has been merged with appendix B.

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			AOO, resulting in excessive spacer wear causing a bundle to no longer be fit for service. Fuel-induced defects could also be considered AOOs according to a failure of level 2 defence in depth, and defects incorporated degradation mechanisms from Appendix B as well.			
75.	OPG, Bruce Power, NB Power, CNL, CNA	Appendix D	Clarification *"This appendix shows examples of acceptance criteria for design-basis accidents."* Given REGDOC-2.4.1, *Deterministic Safety Analysis* clause 4.3 and Appendix B, B.1 and B.2 are extensively about acceptance criteria including examples, is it necessary to have the same, yet fewer examples here? Furthermore, for DBAs the acceptance criterion is licence limits for public dose. The acceptance criteria identified in Appendix D are <u>derived</u> acceptance criteria, applicable to design basis accidents. Lastly, as written, this is very restrictive in terms of dose. Short duration of fuel dryout does occur in several DBAs (< 60 seconds) and fuel sheath is assumed to remain **<u>intact</u>** (no dose) until reactor is tripped.	Remove Appendix D and add any missing information to the revision of REGDOC-2.4.1, *Deterministic Safety Analysis*. Alternately, if kept then suggest rewording as: "*This appendix shows examples of <u>derived</u> acceptance criteria <u>applicable to fuel design</u> for design basis accidents*."		Appendix kept but suggested wording added.
76.	OPG, Bruce Power, NB Power, CNL, CNA	Appendix D	Clarification Confusing table label, "D-A", also in Appendix B.	Use "D-1", etc. to be clearer.		Agreed. Table naming system changed,
77.	OPG, Bruce Power, NB Power, CNL, CNA	Appendix D 4th bullet	Clarification "*Fuel elements (fuel rods) that exceed the critical heat flux (CHF) or depart from nuclear boiling (DNB) criteria are assumed to rupture and contribute to offsite dose.*" is not really an acceptance criterion, but more like a conservative bounding assumption should criteria for this barrier not be met or current knowledge state/code capability not judged sufficient for the conditions.	Recommend removing it. If needed, recommend including a second table that identifies means to conservatively treat shortcomings in knowledge state or simulation capabilities for select fuel behaviours, responses, and failure/damage modes. This will offer guidance on alternative or graded approaches.		Text removed
78.	OPG, Bruce Power, NB Power, CNL, CNA	Appendix D, last bullet	Clarification Examples of acceptance criteria of CANDU fuel contain an example from LWR design.	Remove reference to LWR in the last bullet.		reference to LWR removed
79.	Global First Power	General	MAJOR	The draft document requires additional work and would benefit from one or more technical	This draft REGDOC will require significant interpretation when applied to new build nuclear facility projects where there is a new prospective licensee working with a new reactor	cl See response to comment 3.

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
			The draft REGDOC contains requirements for concepts that appear to better fit within different SCAs including design (2.5.X series REGDOCS), Fitness for service (2.6.X series), Reporting (3.X series) and elements of operational performance, as there is very little discussion directly tied to safety analysis/assessment. While it is recognized that it may be pragmatic to group fuel related requirements together in one document, clarification is requested as to how these requirements interface with other requirements in the other SCAs. For example, the connection between this document and REGDOC 2.5.2, Design for Reactor Facilities: Nuclear Power Plants is not explained even though that document has requirements pertaining to design and qualification of fuel. There is no requirement in REGDOC 1.1.3, *Licence Application Guide: Licence to operate a Nuclear Power Plant* for a specific "Fuel Design Program", only what is contained in section 4.5.8 Design of Fuel System. It is recognized that systematic programmatic elements are necessary but whether it is called a Fuel Design Program remains a subject of discussion. Clarification is needed as to why the focus of the document is primarily on "the licensee". Fuels are not designed by a licensee and, for modern designs may not even be designed to any specific licensee's specifications. The fuels are designed by fuel vendors to be 'mated' to a reactor vendor's technology. There may be some operator discussions (with a stakeholder group of operators) during the generic design process of the fuel, but a specific licensee has a role to decide whether the reactor or fuel design will meet their own requirements. The procurement process establishes this acceptance criteria. As currently written, the Operators who will use this fuel will find it difficult to convince the vendors to put effort in ahead of time to ensure the fuel will be sufficiently qualified.	workshops with stakeholders, including the developers of fuels for new reactor technologies. Stakeholders should include future new licensees, existing licensees AND reactor vendors who are developing and qualifying new fuel. GFP proposes that a first workshop focus on documenting pertinent information about the lifecycle of fuel design from first principles and cover all of the steps of who does what as the fuel goes through qualification and is proposed to be introduced into any reactor facility (test reactor and power reactor). With this information in-hand, the objective of the document can then be clarified to take account of: • the designers who exist before a licensee (many of whom are engaging with CNSC staff as part of the VDR Program) • transition from a design and qualification program into a licensing basis for a facility (i.e., how the REGDOC will be used in the crafting of the license and LCH) • Fundamental responsibilities/accountabilities of a licensee when accepting and using a fuel design. • Adoption and leveraging of information/results from other jurisdictions outside Canada (pedigree and relevance of information to the specific reactor the fuel will be used in) - The draft document should incorporate a specific section that sets requirements on what 'intelligent customer' traits a licensee must have in place to systematically assess and accept a new fuel design. For smaller SMRs, a licensee may be a very small organization who will rely heavily on	technology developer (especially if originating from outside Canada) and referencing fuel that has been designed in advance for that reactor design.	

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
				the vendors. Would a third-party independent review procured by the licensee be acceptable in lieu of the licensee having dedicated and very costly internal capabilities? Similar to how REGDOC 2.5.2, *Design of Reactor Facilities* is written, requirements for the design and qualification of fuel should be written in such a way that it is clear that fuel vendors and reactor developers know that they are expected to address them in their design activities. (i.e. this is examined in Focus Area 4 of the VDR Program).		
80.	Global First Power	General	MAJOR Existing reactor operators in Canada (NPPs and research reactors) have to comply with extensive regulatory requirements that are documented in licence conditions, various REGDOCs and LCHs. In this context, the objective of the proposed draft document is unclear. If it is to document and reflect OPEX and existing practices, then it should say so and could be commented on accordingly. If new requirements are introduced, these should be clearly identified and justified. As a high-level comment, the document does not appear to reflect in all cases current practice and introduces new terminologies and requirements. As a licence applicant and future operator of an advanced reactor technology, GFP is very interested in availability of documented regulatory requirements on all aspects of reactor fuel, from design, qualification, procurement, safety assessment, operation, fitness for service, reporting, change control, transport, disposal, etc… As such, GFP is not opposed to expansion of the scope of the document, or creation of a series of documents addressing fuel and fuel related regulatory requirements and guidance.	Clarify document intent.	The current scope and objectives of the document are very ambitious, and in its present state, does not adequately address scope and objectives, creating uncertainties of expectations for existing licensees and applicants.	CNSC considers regulatory and administrative burden when considering the impact of REGDOC. The content of the document was risk informed and supported the scope.
81.	Global First Power	General – SCA 1.1 Purpose	Clarification The REGDOC number 2.4.5 suggests that the document focuses on safety analysis. • Sections 2, 3, 5, 5, 6 and 9 are more related to SCA #5 on design, including interfaces with safety analysis and	Suggest that two or more documents could be developed under the appropriate SCA for the subject matter: • One that would address fuel design generically, including both existing LWR/PHWR practice, and advanced reactor fuels. This could		See response to comment 3.

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
		1.2 Scope	operational programs (definition of OLCs). Note that there are many overlaps with various sections of REGDOC 2.5.2, *Design of Reactor Facilities*, suggesting that this information would be better placed as supplementary information or appendices to REGDOC 2.5.2, *Design of Reactor Facilities*. • Sections 7 and 8 provide information that may be more related to SCA #6 on Fitness for Service. In general, the current framework has been sufficient to provide guidance on design (including design changes) to fuel for the existing fleet of CANDU reactors, and to address operational programs and measures to address procurement, operation, and waste management considerations. Consideration of new fuel in a reactor core is by itself a major decision. The essential work related to fuel development, design, R&D and qualification will not likely be carried out by the licensee, but by fuel vendors and subject to procurement and verification activities by the licensed operator as per industry practice (N286, CSA standards). This goes well beyond normal operational considerations.	reflect best practices in some areas such as in fuel qualification (NEA "Regulatory Perspectives On Nuclear Fuel Qualification For Advanced Reactors") • One addressing operational considerations including engineering change control process and measures to assure continued for fitness for service of fuel in reactor cores. Creation of a single document to address all aspects and interfaces with other SCAs may be overly ambitious.		
82.	Global First Power	2 and Appendix A	MAJOR It is not clear why the Defence in Depth section caters to only traditional fuel and cladding models. A regulatory document should speak more broadly to the role of fuel, regardless of reactor design, in supporting Control/Cool/Contain safety functions. The proven-ness and effectiveness of fuel design and performance will impact the provisions needed for <u>all 5 levels of DiD.</u> New fuels may require some additional conservatisms to address uncertainties until sufficient OPEX has been gathered; however, the draft document is unclear as to when this appropriate level	Revise Appendix A to be technology neutral and include introductory text such as "The design of fuel, and how it is configured in a nuclear reactor system, plays a primary role in supporting multiple successive barriers to releases of radionuclides under various plant states. For example, any design of a fuel element, whether a ceramic, metallic pellet or next generation fuel such a TRi-structural ISOtropic (TRISO) particle fuel must be able to demonstrate predictable confinement performance when the fuel is maintained within its specified operating conditions. Subsequent physical barriers such as cladding or carbon layers are designed to further support the performance of the fuel element. The design of the fuel also	Lack of clarity in the draft document on the benchmarks being used to judge 'sufficiently proven fuel' to support DiD provisions.	Appendix A has been removed from the REGDOC

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
			of proven-ness has been achieved. Level 5 DiD provisions are very much influenced by the proven-ness of the fuel under accident conditions.	plays a significant role in the predictability of the physics and heat generation in the core which are also integral to maintaining control and responding to operational transients. Regardless of the robustness of the fuel, a defence in depth approach does not solely rely on the fuel but requires that other layered design and control measures be implemented to support the critical safety objectives of Control, Cool and Contain. However, design of fuel elements is increasingly receiving more design attention by fuel designers in order to increase safety performance and justify reduced need for operator and offsite intervention during events. This means that the fuel design and qualification program must be of particularly high quality in order to receive credit for claims of stronger safety performance and any uncertainties in performance of the fuel will need to be addressed through conservative design measures until these uncertainties are resolved to the extent practicable.”		
83.	Global First Power	2. Fuel Safety	Clarification The following statement: “Other reactor designs achieve the same requirements and level of safety for these latter three physical barriers by other means” may be confusing.	Suggest: “Other advanced reactor designs may propose different design provisions and measures to achieve the DiD safety objectives and safety requirements”.		Statement reworded to make it clearer.
84.	Global First Power	3. Fuel design	Clarification This section includes many requirements on licensees that are in practice executed by the fuel vendor. The licensee is responsible to ensure requirements are met through its procurement process. The licensee is responsible for the engineering change control program to ensure acceptability of design changes and compatibility with the reactor design and operational measures.	If the section is on fuel design, the “shall” statements should not be directed to the licensee, but state generically that requirements should be met. If the section is to focus on engineering change control, specific requirements could apply to the licensee.		The text "licensees shall ensure" refers to the licensee’s responsibity to ensure the action, either by itself or a contractor is performed. This is consistent with N286 and N299.
85.	Global First Power	3.1 Fuel design and fuel design limits	Clarification Point 1 states “all facility life cycle”. Clarify if this includes all the fuel life cycle from receipt, handling, irradiation, storage in pool, dry storage and ultimate	Self-explanatory. Clarify.		Facility lifecycle refers to the construction, early operation, late operation and decommissioning of the facility. This phrase is not on the fuel lifecycle, which is dealt with later in section 4.H43

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
			disposal, including compatibility of fuel for permanent disposal.			
86.	Global First Power	3.5 Fuel Design Authority	MAJOR Although the section requires a fuel design authority to be identified, the draft document is unclear as to how much information or what types of information a licensee <u>MUST</u> have regular access to and control over to support their ongoing safety case.	A future licensee of a reactor facility would benefit from a specific requirement or guidance in this draft REGDOC to use as a lever in establishing fuel (and supporting information) agreements with supplier organizations, ie, the appropriate requirements to address potential risks when fuel is procured from international vendor organizations should be added. Globally, fuel vendors are increasingly restricting access to critical information. The vendor has the primary role to support the long-term fuel design and the licensee needs to be able to get reasonable access to this information. An international origin design authority can place long term Canadian plant operation at risk if they restrict licensee access to information necessary to support their safety case or decide to modify the fuel without considering the operating fleet in each jurisdiction. Although the primary effect is commercial viability and not safety, in the case of a large NPP facility, any decision made by a fuel vendor can introduce undesirable provincial/national energy security risks.	Licensees must maintain some form of legal control over the design of the fuel they are using. The smaller reactor facilities will have less influence over international fuel design vendors.	Ppoint 1 of section 3.5 adequately addresses this comment. The licensee's design authority needs to have a sufficient knowledge base to understand and predict fuel behaviour. That would mean they would need an understanding of the design and qualification results. The CNSC does not dictate relationships between licensees and vendors.– CNSC's mandate concerns safety does not extend into energy security risks.
87.	Global First Power	4.8 Design Safety Objectives	MAJOR *"If the fuel design is for a reactor other than a CANDU, the fuel design safety objectives shall be defined following international best practices, but might differ significantly from the guidance provided for currently operating CANDU reactors."* To reduce regulatory uncertainty for non-CANDU reactor fuel types, specifying best international practice would be prudent.	The draft document is currently CANDU oriented. For international best practices for advanced fuel types, NUREG-2246 provides a useful framework that could be adapted into the document to help make it more technology neutral.	This will go a long way in clarifying the regulatory uncertainty for new SMR designs that use TRISO fuel.	The current document is CANDU centric, however, it identifies when and where it may not be applicable to all reactors. the REGDOC balances being general enough to be technology neutral while having specific requirements for the existing industry. Reference to NUREG -2246 has been added.
88.	Global First Power	5.2 Technical Basis	MAJOR *"The licensee shall ensure that the technical basis for the qualification program:*	A) Consider adding the following statements to the draft document to make explicit or rather clarify the intent of what is being requested, as the document is low on the "details", particularly in the fuel qualification section: - fuel is qualified for use, evaluation model is acceptable, and the experimental data used for the assessment are appropriate	This will go a long way in clarifying the regulatory uncertainty for new SMR designs that use non CANDU fuel.	A) Text has been added to 5.2 to add regulatory clarity. B) REGDOC 2.5.2, *Design of Reactor Facilities* – does provide some guidance for first of a kind reactors. Providing guidance on sufficient testing before any first of a kind reactor construction would be near impossible given the variety of technologies possible. High level statements on

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			1. is based upon OPEX or is demonstrated through a program of experimental testing and analysis, or a combination of both, where: *a. the referenced OPEX must be documented and auditable; and* *b. operating experience may be with the same or similar fuel design in the same or a similar reactor design. For any technical basis that is based upon OPEX with similar designs, the licensee shall document and assess the differences between the two designs.* *2. demonstrates the adequacy of:* *a. qualification analysis and modeling;* *b. qualification testing regime; and* *c. the documented design and operating envelope of the fuel."* This section is low on the prescriptive details on what would signify a successful fuel qualification program in the eyes of the regulator vis-à-vis Fuel Qualification, Modelling, data, and QA	-- either physics based, or empirical models be used, with the latter requiring more fuel irradiation tests and data - identify uncertainties and limitations of the evaluation model -- cliff edge effects should be identified - demonstrate that assessment data are available over the entire fuel performance envelope and any gaps be justified - radionuclide retention requirements of the fuel should be specified. - appropriate fission product transport models be developed - fuel performance code and the various deterministic safety analysis codes be V&Ved in line with CSA N286.7, *Quality assurance of analytical, scientific, and design computer programs*. B) A potential 'licensee applicant' for a new build may have a plethora of irradiation tests and post irradiation examinations (PIE) in plan, some may extend beyond initiation of construction of a demonstration plant. Guidance is required in the draft document on what would constitute sufficient testing of fuel for a demonstration plant prior to construction. C) Regulatory guidance in the draft document detailing generic performance objectives for robust fuel would be beneficial on the lines of EPRI TR-110689.		being able to use OPEX from similar fuels in similar reactors is sufficient. Any truly first of a kind that has no peers would need to be treated on a case by case basis. C) The existing level of detail provides sufficient guidance to applicants.
89.	Global First Power	5.2 Technical basis	Clarification Suggest that a qualification program should rely on a systematic analysis of all available data and operational experience for identification of gaps in knowledge and potential new failure modes, and the establishment/execution of a rigorous R&D program	Suggest expanding on expectations and requirements in this section.		Text has been added to guidance to help explain expectations. This text has been added to 5.1.

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
			to address gaps in knowledge. This would include when necessary separate effect testing, and integral testing of fuel representative of all operational state to confirm safety limits and fuel acceptance criteria.			
90.	Global First Power	5.4 Certification	Clarification What does certification mean in this context?	Reword		Guidance has been added to address this issue.
91.	Global First Power	6 Fuel Design Submissions	Clarification In view of the potential significance of fuel design changes to the safety case, the requirements for documentation in this section may be too succinct: - For design changes, one would expect all the documentation related to the Engineering Change Control Process; the list may be a subset. - One would expect completion assurance of fuel design activities including related safety case. -Any need for in-core commissioning/confirmatory testing, and any additional provisions for monitoring should be described.	Reword		The subset of documents represents the minimum that is need to be submitted for review. The requirement for an updated safety case would include the complete impact of the new fuel on the safety case. For a new reactor design or a fuel design that is outside of the existing safety case, approval will be required by the Commission and thus added scrutiny will be required. CAdditional information would be requested as required. The guidance encourages early engagement with CNSC staff, one of the reasons for this is to identify “additional information” that may be required. Additional guidance has been added to clarify that for new reactors the information is expected to be included in the application for a licence to construct the facility.
92.	Global First Power	7. Fitness for service	Clarification Fitness for service assessments are normally conducted when doubt exists on the actual conditions of SSCs to meet OLC limits (or consistency with the safety analyses assumptions) as a result of degradation mechanisms or following upset conditions. For new fuel, fitness for service should be assured by fuel qualification and procurement QA.	Suggest reconsidering statement: “FFS assessments are performed on new or modified fuel designs through the design and qualification process prior to first load”.		Agreed. Section 7 focuses on operation of fuel. Thus the text on design and qualification has been removed.
93.	Global First Power	7.1 Fuel Fitness for Service Criteria	MAJOR This is a key section of the draft document and the requirements and guidance require further clarification and detail in defining the expected	This section needs to be rewritten based on the documented outcomes of stakeholder workshops and should, ideally, be the backbone of the draft document.	Lack of specificity in this area presents a significant impediment to understanding what the requirements are from the fuel qualification process. This presents	Guidance has been added with respect to new reactors.

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
			outcomes of a fuel qualification program. The document is unclear as to what is considered acceptable.		challenges in interactions with the CNSC as early as the VDR process where the reactor vendor is seeking feedback on the program to qualify the fuel. For a new build facility, this introduces significant regulatory uncertainties to the licensing process.	
94.	Global First Power	Fuel Monitoring and Inspection Program e.g. 8.2 Capabilities	MAJOR Section is not clear enough to use in a technology neutral fashion commensurate with risks to nuclear safety. For example, Section 8.10, "*Failed Fuel and Fuel not fit for service*" cannot be interpreted consistently for cores that use TRISO fuel or Molten Salts carriers. Furthermore, the requirement for inspections should be flexible in application – with a focus on outcomes, not the action itself. This is not onerous for reactors with online re-fuelling but could be quite challenged for reactors with cores that are fuelled once for their operating life.	The entire section should be written in a more technology neutral fashion to accommodate other fuel types such as TRISO and metallic fuels which can be managed differently from traditional water-cooled reactor fuels. Requirements around measures to be put in place need to be clear that measures are to be applied consistent with a Graded Approach….that is commensurate with risks to nuclear safety. Evidence, including OPEX, plays a role in addressing uncertainties. Specific to Section 8.10, delete the first two paragraphs and replace with:" *Commensurate with the FFS criteria for the design of the facility, operation of the reactor with defective or a significant quantity of failed fuel for any extended period of time shall be avoided to reduce the effects of fission product releases into reactor systems.* *The licensee shall establish and maintain procedures to mitigate the effects of operation with failed fuel outside the FFS including timely removal of fuel that has been identified as defective or failed, where necessary to meet established criteria*."	Regulatory uncertainties for advanced reactor fuels, along with potentially significant impacts on operations to meet requirements designed for reactors that conduct online re-fuelling.	The text in 8.10 has been modified to improve clarity. The REGDOC is not intended to deal with liquid fuels. For fuels that do not have online or any potential for refuelling, the requirement is that when failed for not FFS fuel is detected, mitigating measures are taken. The expectation is that this would include measures to prevent further degradation or failures and to capture or contain radionuclides released.
95.	Global First Power	8.2 Capabilities	Clarification This section does not appear to include provision for in-core monitoring (capability to identify failed fuel in core).	Expand section		Section 8.2 expanded to include in-core monitoring. Specifying that instrumentation or chemical sampling capabilities are needed.
96.	Global First Power	8.3 Assessment findings	Clarification	Suggest expanding on analysis, trending, and recommended actions.		Trending and identification of causes added to 8.3. Corrective actions are already covered in 8.5

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
			Suggest that the section should be about a systematic assessment of fuel monitoring results, identification of causes and trends, and lead to corrective actions (e.g., removal of failed fuel in core if necessary) and identification of corrective actions.			
97.	Global First Power	8.4 Reporting	MAJOR This requirement duplicates requirements in REGDOC 3.1.1, *Reporting Requirements for Nuclear Power Plants*.	Delete this section	Reporting requirements should be consolidated in one REGDOC, or one risk's introducing discrepancies between REGDOCs.	Pointing tto another REGDOC does not duplicate requirements and adds clarity.
98.	Global First Power	8.5 Corrective actions	Clarification "The licensee shall ensure that the fuel monitoring and inspection program has mechanisms in place to take corrective or mitigating actions". The focus of the requirement should not be solely on having a process in place, but on taking actions.	Suggest: "The licensee shall ensure that the fuel monitoring and inspection program has mechanisms in place to take corrective or mitigating actions on findings that have potential impacts on fuel FFS or on the analysed condition, and that such actions are taken when assessed as necessary"		Agree with the intent of the comment. The program needs to identify and take corrective or mitigating actions. The text of 8.5 has been updated to address this.
99.	Global First Power	8.9 Maintenance of equipment	Clarification Previous sections are relatively silent on on-core monitoring.	Expand section		After review, the current text is sufficient.
100.	Global First Power	9 Fuel Operating Limits and Conditions	MAJOR Section should be interpreted consistently for cores that use TRISO fuel or Molten Salts carriers. In some SMR designs, the fuel (e.g. TRISO) can be very temperature tolerant and other reactor components (e.g. reactor vessel) may fail first. OLCs need to take this into account.	Revise second paragraph to include "…to ensure that fuel and other physical barriers to fission product releases, are not damaged…"	Regulatory uncertainties for advanced reactor fuels.	The focus of this REGDOC is fuel. The point is taken however and a middle ground solution is proposed. The text of 9 has been revised to consider damage of barriers due to fuel.
101.	Global First Power	9. Fuel OLCs	Clarification The following statement is unclear: "When used in conjunction with the operations program, the fuel program shall ensure that fuel is operated within its design and operating envelope." The fuel should always be operated within its design and operating envelop.	Suggest: "The operator shall ensure that the fuel is operated within its design and operating envelope. The operations and the fuel program shall set operational limits and conditions"		The text in an initial section provides an overview of the objectives of the section. The subsections provide the requirements. This suggestion is covered by section 9.1.

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
102.	Global First Power	9.1 Establishment principles	Clarification Statement: "Fuel OLCs shall have the largest safety margins practicable." may not be realistic. Margins have to be quantified and demonstrated as met within levels of uncertainties. The largest practicable margins are when the reactor is shutdown.	Suggest: "OLCs shall be defined consistent with CSA N290.15, *Requirements for the safe operating envelope of nuclear power plants*" Or "OLCs shall be defined consistent with section 4.3.3 of REGDOC 2.5.2, *Design of Reactor Facilities*"		Agree the statement has been removed.
103.	Global First Power	9.2 FFS	Clarification The requirement as stated is unclear. OLCs are defined, among other reasons, to ensure fuel remains fit for service.	Is the intent to include FFS criteria in OLCs during and after all operational state transients. If so, suggest wording such as "The OLCs shall define fitness for service criteria during and following all operational states".		Agreed. Wording in 9.2 updated.
104.	Global First Power	9.3 Modes of Operation	Clarification Guidance is unclear. Prevention of fuel defect conditions should be a requirement. This is particularly important when there is either a new operating organization or there has been significant turnover of staff during the project. (for example, Human Factors issues that arise with changing demographics)	Add new requirement along the lines of "*Planning and execution of new build commissioning, refurbishment and post-refurbishment operations shall implement preventive measure that due account of potential conditions that could result in fuel defects or damage.*" Replace existing guidance with text along the lines of: *Examples of preventive measures include:* *- foreign material exclusion practices when accessing reactor structures systems and components* *- PHT system operation, including pressure testing, with 'dummy' fuel to remove contaminants* *- hot conditioning of the core* *- chemistry control provisions*		Section 9.3 wording has been modified to include several of the suggestions given by this comment. The requirement text has been added in whole and some of the guidance text has been included.
105.	Global First Power	Appendix B	Clarification Section is not applicable to any designs beyond CANDU. However, it can serve as a high-level example.	Change title to "Key Degradation Mechanisms for CANDU facility Normal Operation"		The suggested text has been added to make it clear that while this section is only applicable to CANDU reactors it may have some value to other designs.

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
				Add a paragraph below the table along the lines of: *For other reactor designs and configurations, degradation mechanisms may be similar or unique to the fuel design. The designer and the licensee will be expected to characterize the mechanisms and justify how the list of mechanisms is sufficiently complete.*		
106.	Global First Power	Appendix C	Clarification Section is not applicable to any designs beyond CANDU. However, it can serve as a high-level example.	Change title to "CANDU Degradation Mechanisms" Add a paragraph below the table along the lines of: *For other reactor designs and configurations, degradation mechanisms may be similar or unique to the fuel design. The designer and the licensee will be expected to characterize the mechanisms and justify how the list of mechanisms is sufficiently complete.*		Appendix C has been merged with appendix B thus this comment is closed to #105.
107.	Global First Power	Appendix D	Clarification Section is not applicable to any designs beyond CANDU. However, it can serve as a high-level example.	Change title to "Acceptance Criteria for CANDU facility Design Basis Accidents" Delete first sentence "*This appendix shows examples…*" and replace with: "*For other reactor designs and configurations, the designer and the licensee will be expected to derive the acceptance criteria and justify it as appropriate based on the level of available supporting evidence*."		Agreed. Title changed and text added.

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
108.	Global First Power	Glossary: Definition of Fuel Design	Clarification Fuel design and performance can support all three fundamental safety functions of Control/Cool/Contain, yet the control function is not reflected in the definition. The control function is not just in advanced reactors; use of inherent fuel physics characteristics with changes in temperature is a normal part of Boiling Water Reactor operating practice and is used, to a lesser degree, in PWRs as well.	Revise the definition to reflect that fuel can have a physics control function as well, even if it does vary from one reactor design to another		Definition updated.
109.	Jacques Plourde President & Nuclear Engineering Consultant J.A. Plourde Performance Ltd	General	The REGDOC does not seem to clearly recognize the importance of core management to fuel FFS. Core management expectations should be defined to fill the gap between new fuel and irradiated fuel inspections, that is when the fuel is in core. In addition, core management functions are facilitated by facility-managed software (eg, NUFLASH) which should be properly controlled and secured from cyber attacks.			Comment refers to things outside the scope of the REGDOC.
110.	Terrestrial Energy Inc.	1.2 - para 1	Clarification "It applies, primarily, to **fuel programs and designs that are already licenced**, and to modified or new fuel designs envisioned for operating plants at the time of publication of this document". In our understanding, the CNSC does not licence fuel designs; the CNSC licenses activities (e.g., to prepare site, to construct, to operate, to decommission, to abandon) rather than programs, fuel designs, or facilities.	Change the sentence to "It applies, primarily, to fuel programs and designs that are already licensed **in place in operating plants**, and …".		Wording modified to make it clear that it is for 'existing fuel programs and designs' and removed the implication that we license designs.
111.	Terrestrial Energy Inc.	1.2	MAJOR This section claims that the document remains as technology neutral as practicable and that the high level safety concepts and safety-management requirements associated will apply to designs other	The following change is suggested in the text: "If a designs other than a CANDU reactor**, and specifically solid fuelled reactor designs,** is being **are** considered for licensing in Canada, the associated fuel design, qualification and oversight will be subject to the safety objectives, high	If liquid fuel designs were to attempt to apply this REGDOC, a significant number of the REGDOC's requirements would not apply. Attempting to apply these requirements by exception and/or for the designer to find alternate approaches to each non applicable requirement, this would result in significant effort with very little value.	Agreed. The main target presently for this REGDOC is solid fuels. Specifically, the preservation of the fuel barrier. Liquid fuels require a different set of requirements focusing much more on chemistry which this REGDOC does not cover. However,some sections of this REGDOC will be useful such as having a proper design and qualification process, and OLCs for

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
			than CANDU, where applicable. While this may be true for water cooled reactors and to a fair extent to other solid fuel designs, it is very little applicable to other type of fuels and specifically to liquid fuels.	level safety concepts and safety management requirements associated with this regulatory document, where applicable." In addition, the CNSC staff should consider developing requirements for liquid fuelled reactor designs and append such requirements to this REGDOC or develop a separate REGDOC.		example. Regulatory clarity regarding liquid fuels i may require a a separate AREGDOC.
112.	Terrestrial Energy Inc.	2.0 - para 1	MAJOR *"*Other reactor designs achieve the same requirements and level of safety for these latter three physical barriers by other means". This sentence is not clear as it could be interpreted that the first two barriers exactly as mentioned (i.e., fuel and fuel matrix) are barriers that are expected to exist for all type of fuels; this may not be the case (e.g., liquid fuels).	This statement should be rephrased *"*Other reactor designs achieve the same requirements and level of safety for these latter three physical barriers by other means".	The potential misinterpretation could result in some new fuel designs to be excluded from consideration as potential viable fuels.	Statement reworded to make it clearer.
113.	Terrestrial Energy Inc.	3 – para 1	Clarification It is not clear how fuel design is within safety limits for all levels of DiD? What would those safety limits be for levels 4 and 5 (when the fuel may be damaged)?	Please provide clarification in the text.		Text changed to "all applicable levels of DiD.
114.	Terrestrial Energy Inc.	4.7 - Item 4, Environmental impact	Clarification It is not clear how environmental impact can provide requirements beyond the safety requirements. Maybe the chemical components of the fuel could have certain environmental impacts during fuel fabrication or handling? Or is this about high-level waste management?	Please provide clarification in the text.		The intent of section 4.7 bullet 4 is to consider the environmental impact of the materials and manufacturing process. To give a specific example would be for the design process to identify the environmental impact of using certain toxic brazing materials.
115.	Terrestrial Energy Inc.	5.2 Technical basis	MAJOR Requirement for having OPEX – this not possible for new fuel designs that do not have OPEX or that at most may have only some experimental research available. Note that while the statement in item 1 seem to allow for demonstration through a program of experimental	Please address.	This requirement disallows development or use of new fuel designs, and thus disallows innovation.	Wording modified in (b) to make it clear this also applies to experimental testing. The intent of (a) and (b) was to give guidance to the use of information not directly obtained from prototypical experiments, thus allowing innovation in fuel design.

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
			testing and analysis, the sub-items a) and b) that follow both imply that OPEX is required anyways.			
116.	Terrestrial Energy Inc.	5.4 and 6	Clarification The requirement from Section 5.4 for the fuel to be certified by licensee's fuel design authority does not seem to be reflected in the list of requirements in Section 6. Shouldn't a statement regarding the fuel design certificate be included in the list?	Consider including a fuel design qualification certificate/statement on the itemized list in Section 6.		Agreed. Added to section 6.
117.	Terrestrial Energy Inc.	6 Guidance	Clarification New fuel designs are usually not developed by licensees, but rather by fuel design organizations/entities. What is the vehicle based on which a fuel design organization can engage with CNSC if they are not a licensee, nor engaged in a VDR for example?	Please provide a clarification regarding how a fuel design organization/entity can engage with CNSC (other than through a licensee).	Without a clarification, fuel design organizations/entities seem to be disallowed or discouraged to engage directly with the CNSC.	CNSC staff offer a service to review fuel designs for third party designers/vendors. The process is similar to the VDR process but scaled down to only look at the fuel design and its impacts on the overall safety case. However, the service is outside the scope of the REGDOC.
118.	GE-Hitachi Nuclear Energy	3. Fuel Design	4th bullet: "at all levels of DiD" Given the concept of DiD is general, and somewhat philosophical in nature, it is recommended to revise "at all levels of DiD" to more specific one.	"within its safety limits ~~at all levels of DiD~~ in all applicable facility (or plant) states (or conditions), where each safety limit is explicitly taken into account in the fuel design basis"		Text has been changed to 'all applicable levels of DiD'
119.	GE-Hitachi Nuclear Energy	3.1 Fuel design and fuel design limits	1st bullet: "at all levels of DiD" See Comment #1 above.	"all phases of the facility's lifecycle, and ~~all levels of DiD~~ all applicable facility (or plant) states (or conditions), are taken into account"		Text modified to clarify it is all applicable levels of DiD
120.	GE-Hitachi Nuclear Energy	3.4 Fuel operation and monitoring	The requirement does not well fit in the section title.	The licensee shall ensure that, as part of the fuel design program, the fuel be designed such that the required testing, inspection, monitoring, repair, and replacement, is facilitated ~~successfully performs its safety functions for the facility's design envelope.~~		Agree. This statement appears redundant and has been removed.
121.	GE-Hitachi Nuclear Energy	4.3 Defence in depth	4th item: "extensive testing" An inaccurate term "extensive" is used.	"~~extensive~~ performance testing"		Agreed. Text simplified.
122.	GE-Hitachi Nuclear Energy	9.3 Modes of operation	The label "Mode" has a specific meaning in LWR Technical Specifications and governs all reactor states and operations. • reactor operating modes refer to steady-state and shutdown operation and testing • Testing is defined as operation with permissible	The operational modes for normal operating conditions should include: • Cold shutdown; • Hot shutdown • Hot standby; • power production		Text has been added to 9.3 regarding 'transitional states' to make it clear that the this is for power maneuvering states.

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
			deviations • "Transitional states" refer to operational transients, e.g., plant heat-up and cool down, step or ramp load changes, etc. Special circumstances (e.g., life extension, refurbishment) are considered to reside outside of plant technical specifications that also define Modes of operation and associated OLCs since fuel is not in the reactor core. It is recommended to remove these special circumstances.	operation; • refuelling; • shutting down; • starting up; • commissioning; • transitional states; • maintenance or outage; • life extension; • refurbishment; and • testing.		
123.	GE-Hitachi Nuclear Energy	9.6 Corrosion	This is addressed by maintenance of feedwater/reactor coolant purity. An acceptable method for maintaining water purity levels in the feedwater/reactor coolant, sufficient to protect the fuel, is to ensure that chemistry is optimized to minimize the potential for IGSCC of stainless steel reactor internals and the accumulation of activated corrosion products, which affect after S/D dose rates. The main goals of BWR chemistry controls are to prevent reactor internals damage, minimize after S/D dose rates, and prevent corrosion or excess crud deposition on the fuel. Historically, the first two are more limiting. This is achieved primarily by feedwater chemistry specifications and the condensate treatment system, and supported by the RWCS, which prevents excessive concentration of any impurities introduced via the feedwater system. Water chemistry guidelines to minimize corrosion and deposits are well established and formally documented in EPRI report BWRVIP-130: "BWR Water Chemistry". This aspect of reactor management is delegated to industrial practices that continuously evolve. Water chemistry requirements stipulated in OLCs pertain to significant activity excursions. Reactor water chemistry is continuously monitored to assure compliance to OLCs governing activity excursions as well as to assure	In the fuel OLCs, the licensee shall define the operating parameters to minimize, within acceptable limits, corrosion of the sheath and the 2022-11-08creation of deposits.		Agreed. "In the fuel OLCs" has been removed to provide flexibility.

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
			industrial best practices are maintained. Recommend eliminating "In the fuel OLCs".			
124.	John P. S. Froats, P. Eng. Associate Professor & Nuclear Engineer in Residence, Ontario Tech University	Context of the need / scope of the REGDOC	When reviewing any document, it is helpful to understand what the objective for the document is and the drivers that influence its purpose and contents. I found it difficult to understand some of the content choices. For example: • Requirements for design, design authority and QA requirements for design are provided in REGDOC 2.5.2, *Design of Reactor Facilities*. When I reviewed REGDOC 2.4.5, *Nuclear Fuel Safety* it seemed that there is repeat of REGDOC 2.5.2, *Design of Reactor Facilities* content. For example, section 3.5 speaks to fuel design authority, and design authority is covered in REGDOC 2.5.2, *Design of Reactor Facilities*. There may be a reason for wanting to repeat content but typically repeating content in multiple places becomes challenging for revision and configuration control. Additional information if needed on the topic of design authority might better be placed in REGDOC 2.5.2, *Design of Reactor Facilities* with a pointer to it in REGDOC 2.4.5, *Nuclear Fuel Safety*. Note: There is an aspect of fuel design that is somewhat unique that is NOT currently addressed. Fuel design will typically be done by a company other than the licensee well before application for any licences. At that time, the prospective licensee of an operating facility will not likely be active in fuel design. Perhaps there is a need for guidance how to make the transition from a reactor designer / fuel designer focused on what is needed to address readiness for moving to licensee control and preparation for a licence application.			REGDOC 2.5.2, *Design of Reactor Facilities* is applicable to new reactors and is only guidance for existing reactors. The intent of REGDOC 2.4.5, *Nuclear Fuel Safety* is to be applicable to existing reactors and to the extent practicable to new reactors. As such it is necessary to cover some aspects of 2.5.2 to make those items requirements for existing reactors. The notion of a 3rd party designer has been brought up by several commentors and significant changes to the document have been made as a result.
125.	John P. S. Froats, P. Eng.	Section 3.3	REGDOC 2.4.5, *Nuclear Fuel Safety,* Section 3.3 speaks to the `demonstration of conformance to requirements' with respect to the management system and CSA N286 or equivalent. It might be a			CSA N286 and N299, the standard for supply chain QA address the concerns in the comment. The transition from conceptual work to licensing work is not a new concept to the existing management

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
	Associate Professor & Nuclear Engineer in Residence, Ontario Tech University		statement of what is obvious, but for clarity it might indicate a documented framework equivalent to CSA N286 is requires AND demonstrated evidence that execution of work conforms to what is outlined in the documented framework. As in the point above, the practicality of the evolution of new designs is that conceptual work done by vendors will not be done under this kind of framework and some form of transition is needed at the point where work is being done in support of getting a licence. It may be appropriate to be specific that all work done in support of the safety case for fuel to be submitted in support of a licence must be demonstrated to be done under the auspices of a CSA N286 or equivalent management program.			systems and the use of a graded approach can be applied if needed.
126.	John P. S. Froats, P. Eng. Associate Professor & Nuclear Engineer in Residence, Ontario Tech University	Section 4.1	REGDOC 2.4.5, *Nuclear Fuel Safety* section 4.1 uses wording `shall engage CNSC staff'. I have not typically seen that language used to define the CNSC / licensee interface nor am I aware that it has been defined. Engage has a wide range of interpretation. Typically, language like `must submit XXX for CNSC approval' or `must submit the following documentation for CNSC review X days before fuel being loaded into the reactor' have been used so there is absolute clarity of expectation / requirement.			This wording mirrors existing text in License compliance handbooks. In the long term it is desirable to replace the wording in the LCHs with a simple reference to the REGDOC. So this phrase has been used again for consistency.
127.	John P. S. Froats, P. Eng. Associate Professor & Nuclear Engineer in Residence, Ontario Tech University	Section 4.3	Section 4.3 lists a number of factors to be considered in the defence in depth thinking for the design process. One of the items listed is `use of proven technology'. It seems to me that this does not fit in the list. I think the message trying to be conveyed is that a lot depends on the confidence of the fuel qualification program and that the program will be influenced in terms of extensiveness depending on whether the fuel is used extensively already. Perhaps the item to be listed is a `robust fuel qualification program which takes into account….. A tenth bullet might be appropriate to added : A clearly defined safe operating envelope for the fuel supported by the ability to identify operational non-conformance with that envelope.			The guidance for section 4.3 is not a requirement so the "use of proven technology" does not prevent innovation but encourages where possible to use technology that is fully understood and proven in the field. This can equally apply to the fuel components as to the manufacturing process. The fuel qualification is seen to fit into the " performance testing" bullet. he clearly defined Safe Operating Envelop is a good suggestion for level 1 defence in depth related to this list. This issue is discussed later in the document in section 9. The list was derived from IAEA documents on defence in depth, mostly coming form INSAG-10.

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
128.	John P. S. Froats, P. Eng. Associate Professor & Nuclear Engineer in Residence, Ontario Tech University	Section 5.4	Section 5.4 uses the term `certified for use' by the fuel design authority. This is another term that I have not seen before – historically, fuel design must be approved for use. The point is that if this is some new term it needs to be clearly defined.			Guidance has been added to address this issue in that the design authority certifies the qualification of the design.
129.	John P. S. Froats, P. Eng. Associate Professor & Nuclear Engineer in Residence, Ontario Tech University	Section 5.0	Section 5.0 outlines requirements for the fuel qualification program. There are two aspects that appear to me to be mixed in the section. 1. There is a Fuel Qualification program that satisfies the objective to provide confidence that the fuel will behave in a manner as described in the design submissions in support of licencing for all conditions of operation including: AOO, design basis events and beyond design basis events. This will involve analysis, testing, OPEX review etc. and needs to be done under an appropriate Quality Management program 2. There is A Fuel Qualification program that satisfies the need to demonstrate that the facilities that manufacture fuel can do so with the ability to meet all of the tolerances specified for the fuel in a highly reliable manner, detect non conformances and correct before shipping fuel to be installed in a reactor. Part of this of course is that the fuel manufacturing supplier has the required QA program and demonstrates ongoing conformance to it.			Agree. The one requirement, which is a duplication (3.2), in section 5.0 has been removed. A review of the remaining text was done to confirm it focused on the qualification program and not the fuel manufacturing program.
130.	John P. S. Froats, P. Eng. Associate Professor & Nuclear Engineer in Residence,	Section 6	Section 6 sets a requirement for documentation to be submitted to the CNSC before fuel is loaded. Clarity would be added with some expectation of timeline. I suspect on something so important to safety, the CNSC would want documents submitted well in advance but as written it is not a requirement to do so.			Section 6 requires that they obtain CNSC staff's confirmation that the design is within the licensing basis and is qualified for use prior to loading. They may not load the fuel until they have received our confirmation. The timeline needed to review this documentation would be dependant on the novelty and complexity of the design. This will need to be determined on a case by case basis

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
	Ontario Tech University					and communicated through 'early engagement' between the two parties.
131.	John P. S. Froats, P. Eng. Associate Professor & Nuclear Engineer in Residence, Ontario Tech University	Section 8.8	Section 8.8 uses the terminology that the licensee must `seek acceptance' from the CNSC for inspection frequency. This is another example of terminology with respect to interface with CNSC that if used needs to be defined (is it something different than approval?)			Acceptance means to assent to the terms of an offer. Some common uses of the term "acceptance" in a legal sense include: In the context of contracts, acceptance refers to one person's compliance with the terms of an offer made by another.
132.	John P. S. Froats, P. Eng. Associate Professor & Nuclear Engineer in Residence, Ontario Tech University	Section 9.3	Section 9.3 on modes of operation does not address decommissioning. Maybe this is intentional, but fuel design needs to consider decommissioning and fuel storage which seem to be currently missing from the document.			Decommissioning was not included in the scop[e of the document. Separate REGDOCs and CSA standards address waste and decommissioning.
133.	Jacques Plourde President & Nuclear Engineering Consultant J.A. Plourde Performance Ltd	General	The REGDOC does not seem to clearly recognize the importance of core management to fuel FFS. Core management expectations should be defined to fill the gap between new fuel and irradiated fuel inspections, that is when the fuel is in core. In addition, core management functions are facilitated by facility-managed software (eg, NUFLASH) which should be properly controlled and secured from cyber attacks.			See response to comment 109.
134.	Prodigy Clean Energy	General	The CNSC has not provided a suitable explanation as to why this REGDOC has been placed under the 2.4.X SCA "Safety Analysis". This should be remedied early in the document. It contains requirements for concepts that fit within different SCAs including design (2.5.X series REGDOCS), Fitness for service (2.6.X series), Reporting (3.X series) and elements of operational performance. There is very little discussion directly			See response to comment 3.

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
			tied to safety analysis/assessment. It may be pragmatic to group fuel related requirements together in one document but the CNSC should explain why and include a discussion on how these requirements interface with other requirements in the other SCAs. There is no requirement in REGDOC 1.1.3, *Licence Application Guide: Licence to operate a Nuclear Power Plant* for a specific "Fuel Design Program". Only what is contained in 4.5.8 Design of Fuel System. The requirement for it to be a program in this document appears to come out of nowhere. The focus of the document only on "the licensee" in a number of areas does not make sense and needs to be re-thought. Fuels are not designed by a licensee and, for modern designs may not even be designed to any specific licensee's specifications. The fuels are designed by fuel vendors to be 'mated' to a reactor vendor's technology. There may be some operator discussions (with a stakeholder group of operators) during the generic design process of the fuel.... but a specific licensee has a role to decide whether the reactor or fuel design will meet their own requirements. Requirements for the design and qualification of fuel should be written in such a way that it is clear that fuel vendors and reactor developers know that they are expected to address them in their design activities. (i.e. Focus Area 4 of the VDR Program). As currently written, the Operators who will use this fuel will find it difficult to convince the vendors to put this effort in ahead of time to ensure the fuel will be sufficiently qualified.			
135.	Prodigy Clean Energy	General	A markup of the posted PDF was provided given that a comment table would have been too complicated to craft. The markup contains remarks and suggested changes to specific text. The draft document requires significant additional work and would benefit from workshops with stakeholders, including the developers of fuels for new reactor technologies. The CNSC has not provided a suitable explanation as to why this			Explanation for the SCA selection is discussed in the response to comment #3. REGDOC 2.5.2, *Design of Reactor Facilities* has been reviewed to ensure consistency with this draft REGDOC.

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

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			REGDOC has been placed under the 2.4.X SCA "Safety Analysis". This should be remedied early in the document. It contains requirements for concepts that fit within different SCAs including design (2.5.X series REGDOCS), Fitness for service (2.6.X series), Reporting (3.X series) and elements of operational performance. There is very little discussion directly tied to safety analysis/assessment. It is recognized that it may be pragmatic to group fuel related requirements together in one document but the CNSC should explain why and include a discussion on how these requirements interface with other requirements in the other SCAs. For example, the connection between this document and REGDOC 2.5.2, Design for Reactor Facilities: Nuclear Power Plants is not explained even though that document has requirements pertaining to design and qualification of fuel. There is no requirement in REGDOC 1.1.3, *Licence Application Guide: Licence to operate a Nuclear Power Plant* for a specific "Fuel Design Program". Only what is contained in section 4.5.8 Design of Fuel System. The requirement for it to be a program in this document appears to come out of nowhere. It is recognized that systematic programmatic elements are necessary but whether it is called a Fuel Design Program remains a subject of discussion. The focus of the document only on "the licensee" in a number of areas does not make sense and needs to be re-thought. Fuels are not designed by a licensee and, for modern designs may not even be designed to any specific licensee's specifications. The fuels are designed by fuel vendors to be 'mated' to a reactor vendor's technology. There may be some operator discussions (with a stakeholder group of operators) during the generic design process of the fuel.... but a specific licensee has a role to decide whether the reactor or fuel design will meet their own requirements. The procurement process establishes this acceptance criteria. The REGDOC should incorporate a specific section (e.g new Section 3) that sets requirements on what 'intelligent customer' traits a licensee must have in place to systematically assess and accept a new fuel design. For smaller SMRs, a licensee may be a very small organization who will rely heavily on the vendors. Would a third-party independent review procured by the licensee be acceptable in lieu of the licensee having dedicated and very costly internal capabilities? Similar to how REGDOC 2.5.2, *Design of Reactor Facilities* is written,			Section 3 has been modified to not call it a fuel program. Significant changes to the REGDOC have been made to address 3rd party designers. However the CNSC still requires the licensee to be ultimately responsible for safety. Detailing the relationship between supplier and licensee is at a high level dictated by the supply chain QA program and associated requirements.

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

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			requirements for the design and qualification of fuel should be written in such a way that it is clear that fuel vendors and reactor developers know that they are expected to address them in their design activities. (i.e. this is examined in Focus Area 4 of the VDR Program). As currently written, the Operators who will use this fuel will find it difficult to convince the vendors to put this effort in ahead of time to ensure the fuel will be sufficiently qualified.			
136.	Prodigy Clean Energy	Section 3,4,5.	This is all done by fuel vendors and reactor designers. The operating organization (who will become the licensee using the fuel) has an intelligent customer role to specify their own acceptance criteria to be met. Requirements should be written generically (i.e. Design changes shall be managed....)			The text "licensees shall ensure" refers licensee's responsibility to ensure the action, either by itself or a contractor is performed. This is consistent with N286 and N299.
137.	Prodigy Clean Energy	Section 6,7,8,9	Requirements below the blue line should be targeted to the Licensee			All requirements are applied to the licensee.
138.	Prodigy Clean Energy	Section 1.1	This regulatory document clarifies the requirements and provides guidance for the design, operation	This regulatory document clarifies the requirements and provides guidance for the ~~design~~, design or acceptance (include footnote) operation		No change. Licensees may use fuel from a developer not associated with the facility.
139.	Prodigy Clean Energy	Section 1.2	CNSC does not license technologies	the requirements in this document reflect CNSC's extensive experience with Nuclear fuels from water cooled reactors, in particular CANDU reactors, but are articulated in a manner that is ~~This document focuses on fuel design, operation, monitoring and safety assessments for operating facilities, with implicit concentration on operating CANDU reactors, but remains~~ as technology neutral as practicable. ~~It applies, primarily, to fuel programs and designs that are already licenced, and to modified or new fuel designs envisioned for operating plants at the time of publication of this document.~~ The safety principles and objectives articulated in this regulatory document generally also apply to		Agreed. Change made.

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				~~high-level concepts and technology-neutral information also apply to~~ proposed new reactor facilities, including technologies other than water-cooled reactors. ~~While this document focuses on CANDU fuel, high-level concepts within it may apply to other technologies. If a design other than a CANDU reactor is being considered for licensing in Canada, the associated fuel design, qualification and oversight will be subject to the safety objectives, high-level safety concepts and safety-management requirements associated with this regulatory document, where applicable.~~ "However, it is possible that new nuclear fuels will come with alternative approaches to demonstrate their effectiveness" Include Section 11 of REGDOC 2.5.2, Design of Reactor Facilities here to reinforce use of alternative approaches. This document will be revised as appropriate to incorporate operating experience (OPEX) with new reactor technologies.		
140.	Prodigy Clean Energy	Section 2		~~Fuel Safety~~ The role of fuel in the integrated safety of a facility Defence in Depth (DiD) is a cornerstone of ~~the~~ safety in the........ requirements. (there is no "regulatory Philosophy" only requirements) Canadian regulatory ~~philosophy~~. Each level of defence has its specific objectives, including the protection of relevant barriers and the essential means for this protection... Regardless of fuel technology, the makeup of fuel serves to confine radionuclides to the extent practicable with a specified set of operating limits		Changes in in section 2addresses the concerns expressed.
141.	Prodigy Clean Energy	Section 3		~~Fuel Design~~ Program for control of the fuel design configuration when applied to the specific facility		CNSC staff opted for concise and not overly prescriptive titles. The title of the section was not extended.

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
142.	Prodigy Clean Energy	**1.1 Purpose**	**First sentence**: does not provide for an operator to 'accept' the fuel design developed by a third party vendor**.** In a modern context, fuel developers, in association with reactor developers do the majority of the work to design and qualify fuels. Licensees set user expectations for their supply chain to meet and accept the results through procurement.	Change "*design*" to "*design or acceptance*" and include a footnote that states something along the lines of "*where a fuel developer is not associated with the operator of the facility, the operator, who will be the licensee of the operating facility, has the role to assess and accept the results of the developer's work*."		This does not need to be clarified in the scope, but will be dealt with in the body of the document.
143.	Prodigy Clean Energy	**1.2 Scope**	**First paragraph:** The CNSC has been actively conducting Vendor Design Reviews (VDR) on various water and non-water-cooled technologies since the late 2000s. The scope of the document is limited to existing plants and the rationale for this has not been provided. The scope should cover <u>all fuels,</u> past and future, to the extent practicable, given the importance of fuel qualificaiton to the licensing of new build projects.	Recommend rewriting first paragraph to state something along the lines of "*The requirements in this document are articulated in a manner that is as technology neutral as possible and reflect experience drawn from Canada's CANDU fleet, research reactors and generic lessons learned from pre-licensing activities and international cooperation efforts."* The second paragraph should be rewritten to state: *However, it is possible that new nuclear fuel designs may be designed and demonstrated using alternative approaches. In this regard, the requirements stated in Section 11, Alternative Approaches of REGDOC 2.5.2, Design of Reactor Facilities apply to the demonstration against the requirements in this REGDOC.*		A reference to 3.5.3, *Regulatory Fundamentals* on alternate approach added.
144.	Prodigy Clean Energy	**1.4 National and International Standards**	If SSR 2/1 is to be listed as an international standard, then REGDOC 2.5.2, *Design of Reactor Facilities* should also be listed here as a national standard. They are equivalent documents at the level of the CNSC and IAEA safety frameworks.	List all applicable CNSC REGDOCs here.		NUREG-2246 has been added and SSR 2/1 has been removed from the list. REGDOC 2.5.2 is not a national standard. It is a REGDOC intended to be used by new reactor designs, whereas the primary focus of this REGDOC is existing CANDU reactors.

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
			Non-Canadian users need to understand this up front when using this REGDOC. They are documents that contain 'benchmark requirements and guidance' for Canada and these expectations need to be met.			
145.	Prodigy Clean Energy	**2. Fuel Safety**	Title of section is too vague and does not correctly describe what the section is about. First sentence is inaccurate and vague. CNSC does not have a 'regulatory philosophy'….it has a regulatory framework with requirements and guidance. Recommended enhancement… Experience shows that a fuel design has a role to support the fundamental safety functions of control/cool/contain. This should be stated.	A more correct title is: "**The role of fuel in the integrated safety of a facility**" Change to: "*Defence in Depth (DiD) is a cornerstone of safety in the Canadian regulatory framework.*" Between paragraph 1 and 2, add a new sentence: "*Regardless of fuel technology, the makeup of fuel serves to support control and cool functions but also confine radionuclides to the extent practicable within a specified set of operating limits*"		Change in title of subsection has no impact on the objective of the REGDOC. Regulatory philosophy is correct as per REGDOC 3.5.3, *Regulatory Fundamentals*. Suggested enhanced wording is correct but does not enhance the REGDOC so is unneeded.
146.	Prodigy Clean Energy	**New Section 3 needed to clarify role of operator.**	Rather than having "The Licensee" in every requirement throughout this REGDOC, why not have a specific section between 2.0 and 3.0 that speaks to the OPERATOR's ultimate responsibility to demonstrate safety performance of the fuel throughout the facility lifecycle? Prior to and during construction, they may not be the licensee but they need to be present and specifying their requirements because it will be their plant to operate and they have to know what they are using.... in Operation, they assume full responsibility once the design is turned over. As currently written, the use of the term Licensee is confusing outside of operation.	Add a new section 3 that addresses the areas at left.		The text "licensees shall ensure" refers to the licensee's is responsibity to ensure the action, either by itself or a contractor is performed. This is consistent with the NSCA, N286 and N299. The use of "licensee" has been reduced in sections 4 and 5.
147.	Prodigy Clean Energy		Title of section is too vague and does not correctly describe what the section is about.	Change current Section 3 into Section 4 and give amore descriptive title such as **Programmatic Measures for Control of Fuel Design Configuration**		A title change will not change the content or interpretation of the requirements underneath.
148.	Prodigy Clean Energy	**Section 3: First para**	Title of section is too vague and does not correctly describe what the section is about.	Change current Section 3 into Section 4 and give amore descriptive title such as **Programmatic**		Expanding the title of this section would not add clarity.

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
				Measures for Control of Fuel Design Configuration		
149.	Prodigy Clean Energy	**Section 3 Requirement**	**The use of the terms "*fuel design program*" is not justified by CNSC… what requirements specify that a *Program* is needed rather than programmatic/control measures?**	Noting that the responsibilities of licensees are now clarified in a new Section 3, requirements can be written in more neutral language as follows: "*Systematic programmatic measures shall be implemented to ensure the fuel design configuration includes….. fuel qualification information, applicable operating experience, manufacturing information"….* etc.		The wording has been changed to remove reference to a program, instead using programmatic measures. The requirements have been retained
150.	Prodigy Clean Energy	**Section 3.1: Fuel design and fuel design limits**	**The use of the terms "*fuel design program*" is not justified by CNSC… what requirements specify that a *Program* is needed rather than programmatic/control measures?**	Noting that the responsibilities of licensees are now clarified in a new Section 3, requirements can be written in more neutral language as follows: *"measures shall be implemented to ensure that the fuel design and fuel design limits are established and supported by credible information. Such measure shall be demonstrated to be derived from proven practices"*		The wording has been changed to remove reference to a program, instead using programmatic measures. The requirements have been retained
151.	Prodigy Clean Energy	**Section 3.2 Control of fuel design and design process**	**The use of the terms "*fuel design program*" is not justified by CNSC… what requirements specify that a *Program* is needed rather than programmatic/control measures?**	Noting that the responsibilities of licensees are now clarified in a new Section 3, requirements can be written in more neutral language as follows: "*The fuel design and design process shall be demonstrated to be documented and controlled using suitable and systematic measures.* *Fuel documentation shall be updated in a systematic and timely manner.*		The wording has been changed to remove reference to a program, instead using programmatic measures. The requirements have been retained
152.	Prodigy Clean Energy	**Section 3.3**	**First sentence**: The word "*complies*" is too strong considering that N286-12, *Management system requirements for nuclear facilities* is non-prescriptive and fairly high level. Sentences need to be rewritten to be more clear about proposal of alternatives…. And if/how they must	Noting that the responsibilities of licensees are now clarified in a new Section 3, requirements can be written in more neutral language as follows: First paragraph, change first sentence to "*Codes, standards and specifications on which the supply chain quality assurance is based shall be identified*		There are no inherent barriers to licsensees complying with N286's 'high level' requirements. Section 3.3 has been merged into 3.2 and now is a much more broad statement regarding ensuring documentation and control. Changes to paragraph 2 improves readability

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
			be demonstrated to be consistent with current Canadian practice. For example, is CSA N299.1, *Quality assurance program requirements for the supply of items and services for nuclear power plants, Category 1* the benchmark for acceptance and does equivalency need to be shown? Current text is not clear about this as written.	*and shown to meet the management system requirements of CSA N286-12 Management system requirements for nuclear facilities.*" *Paragraph 2: Change to:* "*Measures for fuel design shall include a manufacturing QA program that ensures the supply chain for fuel employs and justifies an appropriate standard supply chain QA such as CSA N299.1, Quality assurance program requirements for the supply of items and services for nuclear power plants.*		
153.	Prodigy Clean Energy	**3.5 Fuel Design Authority**	**The use of the terms "fuel design program" is not justified by CNSC… what requirements specify that a Program is needed rather than programmatic/control measures?** **Note:** An international origin design authority could potentially place a Canadian facility's long-term plant operational case at risk if they restrict licensee access to information necessary to support their safety case. This should be addressed in requirements	Noting that the responsibilities of licensees are now clarified in a new Section 3, requirements can be written in more neutral language as follows: "*A fuel design authority shall be identified who is responsible for…*" Add new paragraph or put the following new text into new Section 3: "*Regardless of who the fuel design authority is, licensees shall demonstrate that they have appropriate and timely access to design basis information for the purposes of maintaining their licensing basis over the life of the facility*"		Bullet 1, requires the design authority have a fuel design knowledge base. As such, it is sufficient in providing clarity without being overly prescriptive.
154.	Prodigy Clean Energy	**4 Fuel Design Process**	**First sentence: It is agreed that, for operating facilities, the licensees have a major role in fuel designs for their facilities, BUT for new builds,** **1.** Fuels are more commonly designed by third parties who cooperate with reactor vendors (or, in some cases, are the reactor vendor)	Rewrite the first paragraph as follows: "*The complexity of the fuel design process, including the qualification stage, is a function of*		Section 4 has been changed from licensee to designer. The Proposed text pertaining to the licensees responsibilities when procuring a fuel design from a vendor better fit into section 4.2 and have been added there.

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
			long before licensees emerge. 2. Fuels are being designed for use in multiple countries by multiple types of operators **3.** Fuel vendors treat information about the fuel design to be intellectual property and operators must secure supporting information as part of a fuel procurement process 4. The smaller the facility, the smaller the licensee organization will be (economics) which speaks to technical capabilities with regards to fuel. The requirement needs to speak more clearly to the licensee's capabilities.	*the novelty of the design. The design process must take into account all applicable facility states."* **1. Where the licensee drives the fuel design process:** Keep existing text. **2. Where the licensee is procuring a fuel design from a dedicated designer** (e.g. a Westinghouse, GE, Framatome etc) *The licensee must demonstrate it has the technical processes and capabilities in place to assess and accept the requirements and limits the fuel must meet, including how the fuel is produced and how the fuel design is documented to meet the licensee's specific requirements for their facility.*		
155.	Prodigy Clean Energy	**4.1 Notification**	**The use of this clause should only be put in place in a licence or LCH,** not in this REGDOC. The word 'confirm' is not appropriate as the CNSC is not, and should not be treated as an integral part of the licensee's design program. Existing guidance is also not correct given the above.	Delete this requirement. As a compromise, it is possible to rewrite this requirement and guidance differently: *The fuel design configuration information shall be included within the licensing basis information for the facility.* **Guidance:** Changes to the fuel configuration are normally subject to CNSC assessment before the change may be implemented by the licensee.		This section was included to ensure that even extremely small design changes, which may be seen as insignificant, are confirmed to remain within the licensing basis.
156.	Prodigy Clean Energy	**4.3 Defence in Depth**	Need to acknowledge that a licensee may be procuring already designed fuel from a designer rather than expressly designing fuel.	Change first sentence to: "For *either the design of fuel or the assessment and acceptance of a fuel designed by another organization, the licensee shall demonstrate the implementation of the core principles of level DiD…"*		Updated wording to make it more general but did not use suggested change. "The fuel design process shall take into account the core principles of level 1 DiD …"

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
157.	Prodigy Clean Energy	**4.4 Safety Analysis**	Need to acknowledge that a licensee may be procuring already designed fuel from a designer rather than expressly designing fuel. Also need to acknowledge how this regulatory document would be used in the Vendor Design Review process to provide feedback to a reactor vendor who is demonstrating the fuel meets Canadian requirements…	Change first sentence to "*Safety analysis shall be demonstrated to be implemented at an early point in the design process,…"*		Change made to make it more general.
158.	Prodigy Clean Energy	**4.5 Design Consideration Scope**	Need to acknowledge that a licensee may be procuring already designed fuel from a designer rather than expressly designing fuel. Also need to acknowledge how this regulatory document would be used in the Vendor Design Review process to provide feedback to a reactor vendor who is demonstrating the fuel meets Canadian requirements…	Re-write both requirements as follows: "*The design of the fuel and demonstration of fitness for service shall take into account the reactor conditions for all facility states within the design envelope from commissioning to core end-of-life conditions*."		Change made to make it more general.
159.	Prodigy Clean Energy	**4.6 Input to design process considerations**	Need to acknowledge that a licensee may be procuring already designed fuel from a designer rather than expressly designing fuel. Also need to acknowledge how this regulatory document would be used in the Vendor Design Review process to provide feedback to a reactor vendor who is demonstrating the fuel meets Canadian requirements…	Rewrite requirement as follows: "*The design process shall contain documented measures of how the following were taken into account in design decision making:"*		Change to text made: "The design process shall document how the following were taken into account: "
160.		**4.7 Design Requirements**	Requirements and guidance should be placed into the recommended new section 3 to have one section in this REGDOC that speaks to the licensee's responsibility w.r.t. the fuel configuration in the supply chain.	Move requirement and guidance to new section 3 which is devoted to what the licensee is expecting of their fuel design supply chain.		No change was made as Section 4.7 is about the design process requirements not the supply chain.
161.	Prodigy Clean Energy	**4.8 Design Safety Objectives**	Requirements and guidance should be placed into the recommended new section 3 to have one section in this REGDOC that speaks to the licensee's	Move requirement and guidance to new section 3 which is devoted to what the licensee is expecting of their fuel design supply chain.		C N299 provides the needed guidance with respect to the supply chain. There is no need for a repetition of those requirements in this REGDOC.

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
			responsibility w.r.t. the fuel configuration in the supply chain.			
162.	Prodigy Clean Energy	**4.9 Degradation mechanisms**	Need to acknowledge that a licensee may be procuring already designed fuel from a designer rather than expressly designing fuel. Also need to acknowledge how this regulatory document would be used in the Vendor Design Review process to provide feedback to a reactor vendor who is demonstrating the fuel meets Canadian requirements…	Rewrite requirement as follows: "*Degradation mechanisms and associated* *limits that may challenge the fuel design shall be characterized and include relevant information from research and development activities and operating experience. In addition:"* Then, keep existing list as is.		Leading sentence modified to make the requirement more general and not state the licensee needs to perform this step, but that it has to be done as part of the design process.
163.	Prodigy Clean Energy	**4.10 Documentation**	Need to acknowledge that a licensee may be procuring already designed fuel from a designer rather than expressly designing fuel. Also need to acknowledge how this regulatory document would be used in the Vendor Design Review process to provide feedback to a reactor vendor who is demonstrating the fuel meets Canadian requirements…	Rewrite requirement as follows: "*The fuel design process shall document the fuel design and describe how it* *meets the identified requirements."*		Agreed
164.	Prodigy Clean Energy	**5. Fuel Qualification Process**	In the modern context, fuel qualification is performed by the designer (a fuel company and/or reactor designer), who is not normally the licensee. As a result, This requirement should actually have 2 parts: 1. What the fuel designer (e.g. vendor) does. (stays here) and; 2. What the licensee is expected to do (put a requirement in NEW Section 3)	Move existing requirement to new Section 3 which will cover a licensee's responsibilities for demonstrating safety performance of fuel as part of their licensing basis. Add new requirement here along the lines of the following: "*The designer shall ensure that qualification of the manufacturing process complies with the manufacturing QA program described in section 3.3, Management system and quality assurance*."		Section 5 has been modified to make who is required to perform the actions more generic to address this concern. As a result, no new section is required.

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
165.	Prodigy Clean Energy	**5.1 Qualification objective**	In the modern context, fuel qualification is performed by the designer (a fuel company and/or reactor designer), who is not normally the licensee. A new section 3 would covers off the requirements for a licensee to assess and accept the results of what the designer develops and qualifies	Change requirement to: *"As part of the qualification program, the designer shall demonstrate that the design meets all of the requirements and the associated limits."*		Section 5 has been modified to make who is required to perform the actions more generic to address this concern. As a result, no new section is required.
166.	Prodigy Clean Energy	**5.2 Technical Basis**	In the modern context, fuel qualification is performed by the designer (a fuel company and/or reactor designer), who is not normally the licensee. A new section 3 would covers off the requirements for a licensee to assess and accept the results of what the designer develops and qualifies	Rewrite the opening sentence to the following: *"The technical basis for the qualification program shall:"*		Agreed. Wording changed.
167.	Prodigy Clean Energy	**5.3 Management system and quality assurance AND 6. Fuel Design Submissions**	In the modern context, fuel qualification is performed by the designer (a fuel company and/or reactor designer), who is not normally the licensee. A new section 3 would covers off the requirements for a licensee to assess and accept the results of what the designer develops and qualifies. Existing section 6 wording is vague and does not show consistency with the expectations contained in REGDOC 2.5.2, *Design of Reactor Facilities* and Licence application guide REGDOCs 1.1.2, *Licence Application Guide: Guide to Construct A Reactor Facility* and 1.1.3, *Licence Application Guide: Licence to operate a Nuclear Power Plant*. In addition, regarding the phase: "*obtain CNSC staff's confirmation that the design is within the licensing basis and is qualified for use*" The CNSC is not, and should not be treated as an	Move all requirements to new Section 3 and more clearly align fuel design submission requirements with references in REGDOC 2.5.2, *Design of Reactor Facilities* and REGDOCs. 1.1.2, *Licence Application Guide: Guide to Construct A Reactor Facility* and 1.1.3, *Licence Application Guide: Licence to operate a Nuclear Power Plant*. Remove or re-cast to be aligned with CNSC's mandate to be independent of the licensee's responsibilities: "*obtain CNSC staff's confirmation that the design is within the licensing basis and is qualified for use*" The requirement should establish what CNSC will accept as appropriately conducted independent verification (internal licensee processes? Or third party?)		The REGDOC was modified to reflect that fuel qualification is often performed by a third party. The existing requirements to have a supply chain QA consistent with N299 addresses the comment that the licensee is required to assess and accept the designers work. The CNSC is not part of a licensee, vendor or proponent's licensee design program. The confirmation process is a review of the licensees arguments that the change is within the licensing basis. Whether this is a licensee internal or external verification or not would not matter.

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
			integral part of the licensee's design program. The licensee should be obtaining independent verification/confirmation and then demonstrating to the CNSC why the design is within the licensing basis and is qualified for use			
168.	Prodigy Clean Energy	**7 Fuel Fitness for Service**	This entire section does not interface or demonstrate alignment with other CNSC requirements for fitness for service and needs a significant revisit for scope in this REGDOC. Fitness for service is not just measuring fuel that is being used, but also includes the aspects of fuel qualification necessary to allow the fuel to be loaded into a reactor core. This is particularly important for new reactor designs. In the modern context, fuel qualification is performed by the designer (a fuel company and/or reactor designer), who is not normally the licensee. The licensee then receives a handoff of technical information necessary to demonstrate fitness for service over the life cycle of the fuel.	This section should receive specific focus in workshops hosted by CNSC that include new fuel developers, reactor vendors and existing/future licensees.		Noted. Section 5 deals with fuel qualification. Section 7 sets the FFS limits from the qualification and design process. Then states that there needs to be a process to identify when and how assessments are performed to confirm fuel remains FFS. Section 8 is the monitoring and inspection to confirm fuel is/was FFS.
169.	Prodigy Clean Energy	**7.1 Fuel fitness for service criteria**	In the modern context, fuel qualification is performed by the designer (a fuel company and/or reactor designer), who is not normally the licensee.	Rewrite requirement as follows: "*The designer shall, in consideration of operational requirements, identify and document, to the extent practicable, the fuel FFS criteria*."		Section modified to clarify that the licensee is responsible for ensuring the action is accomplished, but is not necessarily the entity performing the action.
170.	Prodigy Clean Energy	**7.2 Technical Basis, 7.3 Fuel fitness for service assessments AND 7.4 Record keeping**	In the modern context, fuel qualification is performed by the designer (a fuel company and/or reactor designer), who is not normally the licensee.	Move existing requirement to new Section 3 which will cover a licensee's responsibilities for demonstrating safety performance of fuel as part of their licensing basis.		Existing wording is sufficient as it does not specify that the licensee is the performer of the action.
171.	Prodigy Clean Energy	**8. Fuel Monitoring and Inspection Program**	**Entire Section**: Because all of this falls under the Operator's jurisdiction, put all of this in new Section 3. This is no longer "designing and qualifying the fuel" but rather situational awareness that the fuel performs within its design specs....	Move existing requirement to new Section 3 which will cover a licensee's responsibilities for demonstrating safety performance of fuel as part of their licensing basis.		The REGDFOC was not reformatted. CNSC regulates licensees and this REGDOC is intended for operating plants. REGDOCs are only obligations when placed within a license of LCH. Vendors using this REGDOC are expected to use the graded approach and ignore sections that are

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
						not intended to apply to them. The REGDOC is as technology neutral as possible at the present time.
172.	Prodigy Clean Energy	**8.2 Capabilities**	Write requirement in a m ore technology neutral format.	Rewrite requirement to the following: *"The monitoring and inspection program shall include, as applicable to the fuel type and fuel handling and storage configurations, onsite and in-bay* *inspections of fresh and irradiated fuel and, if necessary, hot-cell examinations."*		The REGDOC is v primarily targeted at CANDU fuel and that the graded approach will be used for other fuel types. The present wording is sufficiently technology neutral in that e only fresh and irradiated fuel inspection s are required and that the licensee needs to ensure these inspections are done. Inspections can be conducted by third parties.
173.	Prodigy Clean Energy	**8.4 Reporting**	This requirement is already in REGDOC 3.1.1, *Reporting Requirements for Nuclear Power Plants*. Repeating it here has no value other than to duplicate the requirement.	Delete Section 8.4.		See response to comment 97.
174.	Prodigy Clean Energy	**8.5 Corrective Actions**	The listed guidance is not actually guidance and should be merged into the requirement. Requirements needs to reinforce the need to use <u>proven</u> mechanisms and that any action will be commensurate with safety importance. Any pre-licensing engagement should seek to understand what these will be on a case-by-case basis for the fuel design being proposed.	Modify existing requirement to: *"The licensee shall ensure that the fuel monitoring and inspection program has proven mechanisms in place to take corrective or mitigating actions on findings, commensurate with importance to safety, that have potential impacts on fuel FFS or on the analysed condition."* *And delete the guidance.*		Agree with the intent of the comment. The guidance has been merged into the requirement text of 8.5.
175.	Prodigy Clean Energy	**8.6 Trending**	Fuel designers and vendors are see their information as proprietary and will control what is released to licensees. A large power plant licensee has 'clout' to get reasonable access to access to this information. However, smaller licensee organizions with smaller facilities have less "clout" to compel this information to be provided. Lack of access can hamstring the licensee and introduce significant uncertainties to the long term operation of the facility. It can also become a national security and/or energy security issue if not	Revise requirement to: *"The licensee shall demonstrate it has suitable access to the designer's technical information to define levels related to expected fuel conditions and degraded states in order to identify negative trends"*		The intent of 8.6 is to have operators define and trend fuel performance metrics relevant to phenomena they are observing. These metrics do not need to have designer specifications, thus there should be no issue with vendor or designers withholding information.

<u>Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*</u>

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
			addressed up front. The existing requirement needs to confirm that the licensee has secured this access			
176.	Prodigy Clean Energy	**8.7 Inspection process**	Requirement needs to include a connection to maintaining safeguards provisions. This is important for SMR designs where fuel is not contained in a distinct fuel element, such as a molten salt reactor. Second paragraph in Guidance should be written in technology neutral language.	Revise requirement to: "*Where sampling is used, the licensee shall ensure that there is a documented inspection sample* *selection process that conforms to facility safeguards provisions and requirements".* *Change second sentence in guidance to:* *"Targeted surveillance should result in selection of fuel samples/elements that represent different conditions in the reactor".*		Safeguards has intentionally been left out of this REGDOC. The second paragraph of the guidance has been modified from bundle to just fuel to be more technology neutral.
177.	Prodigy Clean Energy	**8.8 Inspection**	Second sentence of requirement: "other challenges" is too vague. New reactors with new fuel designs will be going into service and some form of in service inspections are likely going to be warranted to make up for a lack of long term OPEX. First sentence of guidance "*for relevant information*" is too vague.	Rewrite second sentence to state: "*The proposed acceptable level of inspections shall take due account of degradation mechanisms and remaining uncertainties identified in the fuel qualification process*." Rewrite first sentence of guidance to state: *"Fuel removed from the core due to it not being, or being suspected of not being, fit for service should be inspected to understand, document and address the root cause of the fitness for service issue"*		No change due a lack of certainty concerning future technological and fuel designs. However, the proposed text was added to improve clarity.
178.	Prodigy Clean Energy	**8.9 Maintenance of Equipment**	Requirement as written is too vaue. What does "*properly*" mean?	Rewrite requirement to state: *"The licensee shall ensure that equipment used to monitor for, locate and remove fuel that is not fit*		Text changed to indicate the equipment is "capable and functional"

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
				for service is maintained to its fitness for service specifications"		
179.	Prodigy Clean Energy	**8.10 Failed Fuel and fuel not fit for service**	Existing requirement is CANDU/LWR centric and should be written in a technology neutral manner. A number of advanced reactor designs, including one referenced in a licensing process in Canada utilize fuel (e.g.TRISO), a vert small portion of which may be considered to be "defective/failed before the reactor even starts up. Some SMR designs are proposing sealed cores (no access for refueling or access to fuel is only design at end of core life). Operation, in this state has been demonstrated, to a degree, in other countries to be acceptable as long as sufficient monitoring/controls are in place to determine whether acceptable operational thresholds have been exceeded (normally well below anything that would lead to potential for significant consequences)	Rewrite the first two paragraphs of the requirement to state something along of the lines of: "*Commensurate with the FFS criteria for the design of the facility, any operation of the reactor with defective or failed fuel for any extended period of time shall give first priority to minimizing the effects of fission product releases into reactor systems.* *The licensee shall establish and maintain procedures to mitigate the effects of operation with failed fuel outside the FFS including timely removal of fuel that has been identified as defective or failed.*" *Add new guidance along the lines of:* "*A longstanding safety practice as a result of operational experience is to avoid operation of the reactor for any extended period of time with defective or failed fuel. For water-cooled reactors, this remains a fundamental safety practice that must be met. However, a number of advanced reactor fuel designs have characteristics that result in alternative definitions of defective or failed fuel that need to be addressed within the safety case of the facility. The fuel fitness for service criteria serve as a basis to demonstrate how defective/failed fuel will need to be addressed in a timely manner to ensure that a strong Defence in Depth is maintained at all times.*"		The first paragraph is in line with intent of this comment. If there is failed fuel that can not be removed then mitigating actions need to be taken. The following two paragraphs have been moved to guidance.
180.	Prodigy Clean Energy	**9 Fuel Operating Limits and Conditions**	In some SMR designs, the fuel (e.g. TRISO) can be very temperature tolerant and other reactor components	Modify existing requirement to state the following:		The focus of this REGDOC is fuel. The point is taken however and a middle ground solution is proposed. The text of 9 has been revised to consider damage of barriers due to fuel.

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			(e.g. reactor vessel) may fail first. OLCs need to take this into account.	*"In conjunction, these programs set operational limits and conditions (OLCs) to ensure that fuel and other physical barriers to releases is not damaged during normal operations or AOO conditions."*		
181.	Prodigy Clean Energy	**9.3 Modes of operation**	New requirement is needed to address commissioning of new reactor designs or refurbished reactors. Existing guidance is weak with a poorly explained basis. Prevention of fuel defect conditions should be a requirement.	Add new requirement: *"Planning and execution of new build commissioning, refurbishment and post-refurbishment operations shall implement preventive measure that take due account of potential conditions that could result in fuel defects or damage."* Delete guidance.		Text has been added but guidance has been retained.
182.	Prodigy Clean Energy	**9.4 Entering new operating conditions**	A guidance statement would be useful to include some examples	Add guidance statement: *"Examples of preventive measures include:* *- foreign material exclusion practices when accessing reactor structures systems and components* *- PHT system operation, including pressure testing, with 'dummy' fuel to remove contaminants* *- hot conditioning of the core* *- chemistry control provisions"*		Some of the proposed guidance listed has been included. An exhaustive list was not provided as the preventive measures employed will be highly specific to the situation.
183.	Prodigy Clean Energy	**Appendix A**	Appendix overall needs to be rethought. Why is it CANDU specific when it does not need to be? There is enough CNSC experience with other reactor designs such that this appendix can be written in a technology neutral manner. The DiD story should not repeat what is already in	**A number pf suggestions are provided below to make Appendix A more useful to key stakeholders such as designers.**		Appendix A has been removed.

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			other regulatory documents, but rather to speak to the role of fuel design in DiD.			
184.	Prodigy Clean Energy	**Appendix A**	**First paragraph** – make technology neutral and merge with second paragraph: "*Defence in Depth (DiD) is a cornerstone nuclear safety principle and objective both in Canada and around the world. Each level of defence in depthhas its specific objectoives, including the protection of barriers to releases and the means for ensuring this protection is reliable under the applicable plant states.* REGDOC-3.5.3, *Regulatory Fundamentals*, Regulatory Fundamentals [5] provides information on the principles of DiD." Add new paragraphs below new first paragraph: *"The design of fuel, and how it is configured in a nuclear reactor system, plays a primary role in supporting multiple successive barriers to releases of radionuclides under various plant states. For example, any design of a fuel element, whether a ceramic, metallic pellet or next generation fuel such a TRi-structural ISOtropic (TRISO) particle fuel must be able to demonstrate predictable confinement performance when the fuel is maintained within its specified operating conditions. Subsequent physical barriers such as cladding or carbon layers are designed to further support the performance of the fuel element. The design of the fuel also plays a significant role in the predictability of the physics and heat generation in the core which are also integral to maintaining control and responding to operational transients.* *Regardless of the robustness of the fuel, a defence in depth approach does not solely rely on the fuel but requires that other layered design and control*			Appendix A has been removed.

Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
			measures be implemented to support the critical safety objectives of Control, Cool and Contain. However, design of fuel elements is increasingly receiving more design attention by fuel designers in order to increase safety performance and justify reduced need for operator and offsite intervention during events. This means that the fuel design and qualification program must be of particularly high quality in order to receive credit for claims of stronger safety performance and any uncertainties in performance of the fuel will need to be addressed through conservative design measures until these uncertainties are resolved to the extent practicable. Keep existing text: *The CNSC has formulated requirements and provided guidance regarding fuel design, degradation mechanisms and associated limits, qualification, monitoring, inspection and operations, to ensure the application of DiD principles to all fuel-related activities so that the fuel will perform in accordance with its design safety objectives during both operational states and accident conditions. These formulated requirements and guidance can be categorized into their respective levels of defence:* *Level 1 DiD is achieved by robust engineering and construction. To ensure this, it is imperative that the fuel design and qualification processes are comprehensive and that the manufacturing is controlled. Fitness for service limits in conjunction with operating limits and conditions are defined to inform and prevent operations from deviating outside the licensing basis.* *Level 2 DiD is achieved by having appropriate fitness for service limits to support level-2 deterministic safety analysis. Level 2 is further enhanced by having a functioning monitoring and inspection program to identify deviations and abnormalities and take corrective actions to return the fuel condition to*			

#	Commenter	Section	Issue	Suggested Change	Impact	Disposition
			normal. Level 3 & 4 DiD is achieved by having documented and understood failure mechanisms and safety criteria in conjunction with a robust fuel design, such that if a design basis accident did occur, the fuel behaviour would be understood and the barrier protected as per the fuel design basis. For beyond design basis accidents (level 4), the understanding and protection should be to the extent practicable			
185.	Prodigy Clean Energy	**Appendix A**	Level 5 DiD: Existing statement is not correct as written.	Revise to: "*The need for, and effectiveness of any offsite response provisions under Level 5 is directly informed by the evidence that the fuel will perform predictably and effectively within the provisions for Levels 1-4*."		Appendix A has been removed.
186.	Prodigy Clean Energy	**Appendix B**	Section is only applicable to CANDU OPEX. Title should reflect this.	Change title to: "***Appendix B: Examples of Key Degradation Mechanisms for CANDU facility Normal Operation***" Replace opening sentence "This appendix…" with the following: "*For other reactor designs and configurations, degradation mechanisms may be similar or unique to the fuel design. The designer and the licensee will be expected to characterize the mechanisms and justify how the list of mechanisms is sufficiently complete*."		See the response to comment105.
187.	Prodigy Clean Energy	**Appendix D**	Section is only applicable to CANDU OPEX. Title should reflect this.	Change title to: "***Appendix D: Acceptance Criteria for CANDU Design Basis Accidents***"		Agreed. The title of the appendix has been modified to make it more clear these are specific to CANDU

<u>Comment Table for draft REGDOC-2.4.5, *Nuclear Fuel Safety*</u>

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				Replace opening sentence "This appendix…" with the following: "*For other reactor designs and configurations, the designer and the licensee are expected to derive the acceptance criteria and justify it as appropriate based on the level of available supporting evidence*."		
188.	Prodigy Clean Energy	**Glossary**	The definition of fuel design does not acknowledge that fuel also has a significant role in the Control Function in most reactor configurations. This is particularly true for advanced reactors where inherent control characteristics is a consideration in fuel design.	Please reflect the Control safety function in fuel design.		A modification to the wording has been made to include control in the definition.