Lessons Learned on NBSR Licensing Actions

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Disclaimer

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Introduction

NBSR implemented three license amendment requests (LAR) as part of the recovery

1st was to modify previous latch verification requirements in the Technical Specifications (TS)

2nd evaluated the safety and operational impacts of fuel debris remaining within the primary system

3rd evaluated the use of specific methodologies to perform core loading analyses for Alternative Core Loadings

Outline

- Description and necessity of each LAR
- Documentation and analysis requirements
- Lessons learned throughout the process
- Discussion
- Summary

LAR #1 Fuel Latch Verification Requirements

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- **The Reactor Operations and Engineering (ROE) group discovered that the current rotational latch verification check was insufficient**
- **The discovery that the pickup tool's physical contact with the latch during latch verification could be a potential reason for unlatching => a non-contact method of verification**
- **Originally TS required operators to perform one of the three methods, namely the elevation check, rotational check, or visual inspection for latch verification**
- **Corrective actions => improvements in latch verification methods and requiring both rotation and visual checks**

LAR #1 Fuel Latch Verification Requirements

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Rotation Check

Upon movement of a fuel element to its intended position in the core grid, the final mechanical manipulation is to push down on the fuel element head via the pickup tool and compress the spring on the head to move the latch to below the bottom of the upper grid. The tool is then rotated counterclockwise about 45 degrees to its full stop position thus moving the latch underneath the notch in the upper grid. The tool is then raised slightly to release the spring, thus setting the latch into the notch.

LAR #1 Fuel Latch Verification Requirements

Fuel element head latched into a mockup of the upper grid plate.

LAR #1 Fuel Latch Verification Requirements

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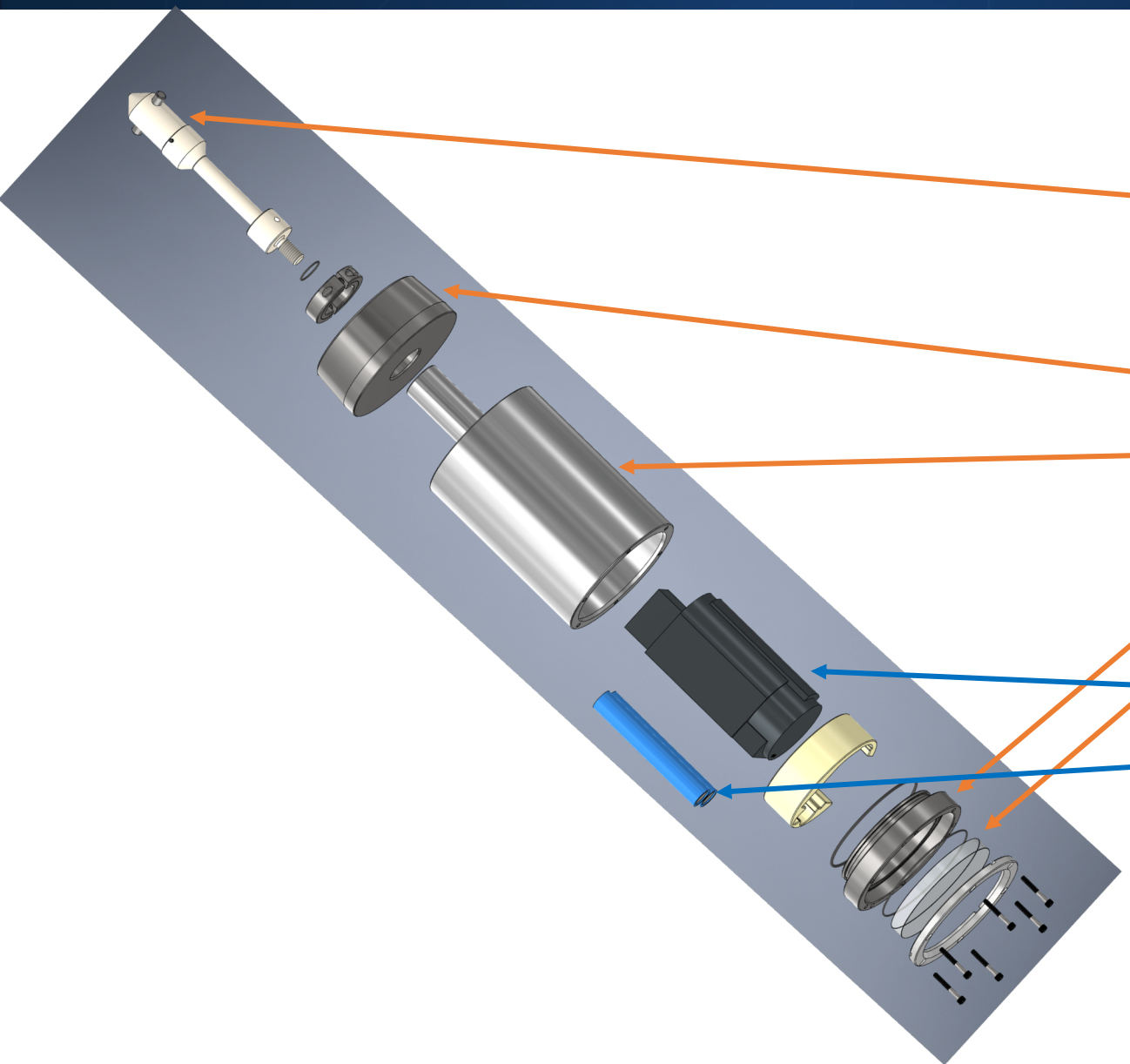
Visual Check

After the rotation checks are complete and all tools are in their stowed positions, a newly constructed camera system is set to "record" and is then placed into the fuel transfer system. This camera system is then systematically moves through the fuel transfer system and in turn positioned immediately over each element position. Once the camera has traversed the entire system it is retrieved. The video is uploaded and reviewed by an operator. The operator, along with a second person, verifies and documents that each element is shown to be latched

Visual Inspection Tool



Shape

- Weight and feel
- Head of the tool
- Their training translates to this tool

Material

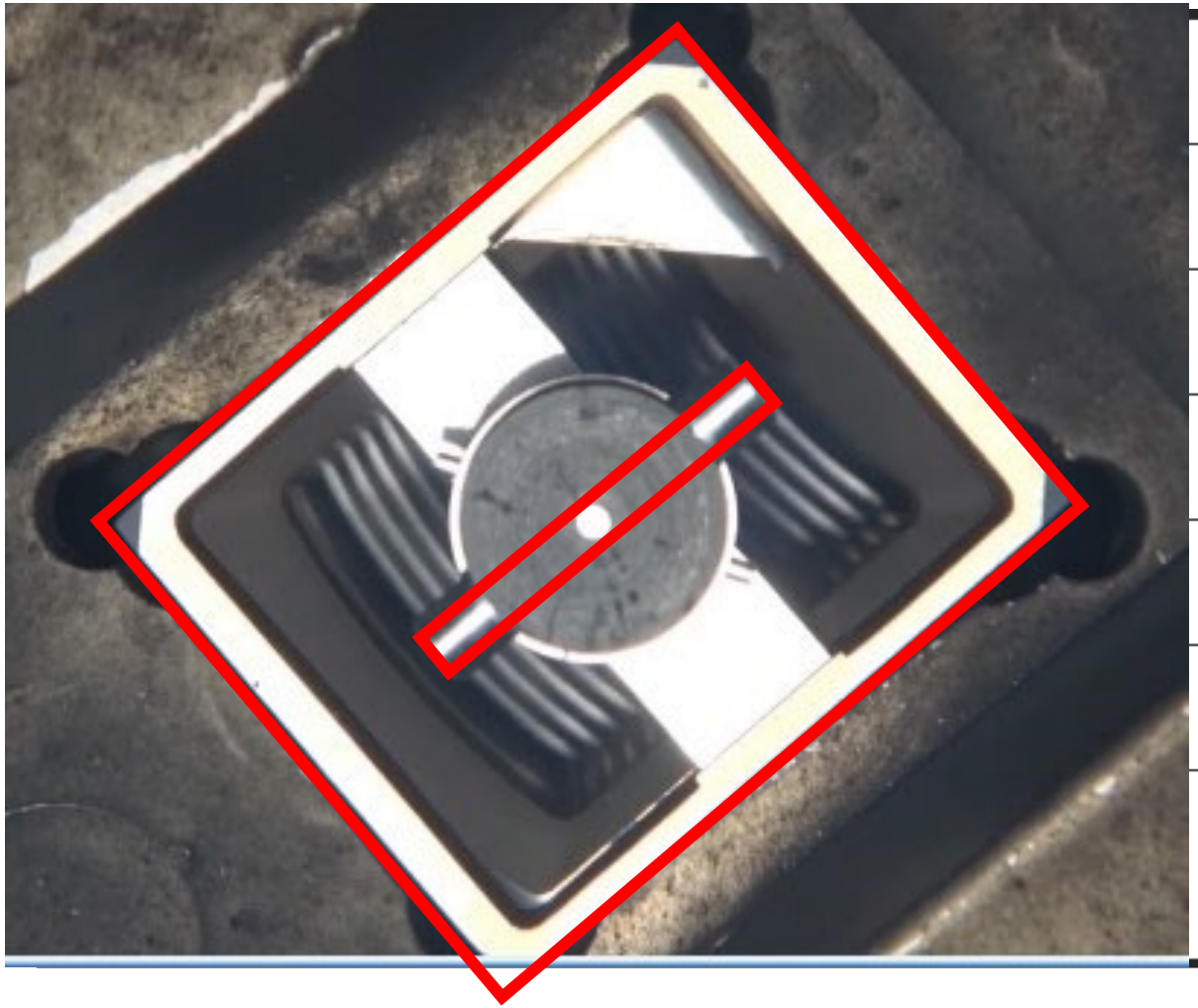
- Ballast – Stainless steel
- Housing - Aluminum
- Window frame, Retainer rings – Stainless Steel
- Window – Polycarbonate

Illumination and imaging

- Camcorder
- Pen light

Second video of reactor top

LAR #1 Fuel Latch Verification Requirements



J-1	
	324
	328
ABS (DELTA)	4
ACCEPTED ABS (DELTA) ≤ 2	
REJECTED ABS (DELTA) > 2	X

Video capture of the element in the latched position

Discussion

Documentation was straightforward

TS change included additional conservatism

Documented all LAR paperwork to the regulator

LAR #2 Existence of Fission Products in Primary Coolant

- **There had been fission products and fuel material released to the primary cooling system during the event**
- **Based on measurements, a maximum of 200 grams of fuel and clad mixture were determined to be missing**
- **Fissile Uranium in these particulates would undergo fission and release fission products**
- **Evaluated the safety and operational impacts of such debris remaining within the primary system**

LAR #2 Existence of Fission Products in Primary Coolant

- **The effects of friable unclad fuel present in the reactor dose release consequences**
- **Potential mechanical effects**
- **“An increase in consequences from a proposed activity is defined to be no more than minimal if the increase is less than or equal to 10 percent of the difference between the current calculated dose value in the UFSAR and the regulatory guideline value” NEI 21-06 Rev - 1 section 4.3.3**

Discussion

- **Detailed neutronic analysis was completed to evaluate release rates**
- **Health Physics analysis completed to estimate dose at boundary worst case scenario**
- **Main criteria was the change in dose rate less than 10% of the difference between the limit and original dose value**

LAR #3 Alternative Fuel Management Schemes

- **Debris was found on several fuel elements and all of the fuel elements in core loading 654 were deemed unusable**
- **Only the 7th cycle and fresh fuel elements are available in the NBSR inventory**
- **Develop a series of Alternative Fuel Management Schemes (AFMS) approach the equilibrium core**

LAR #3 Alternative Fuel Management Schemes

- **Any such AFMS is a modification in how the NBSR core performs its design function of producing 20 MW and therefore requires a License Amendment Request (LAR)**
- **Furthermore, Technical Specifications Section 5.3 Basis bullet (1) in part states that "Significant changes in core loading patterns would require a recalculation of the power distribution to ensure that the CHFR would be within acceptable limits."**

LAR #3 Alternative Fuel Management Schemes

- **A new section was inserted in the NBSR UFSAR, “4.5.1.1.3 Alternative Fuel Management Schemes (AFMS)”, which describes bounding conditions for any AFMS**
- **The third LAR introduced an engineering procedure, namely “NBSR-0018-DOC-00 NBSR Alternative Fuel Management Schemes Analysis Procedure” which described the OFMS and AFMS, a basis for the analysis providing limitations to evaluate potential AFMS, detailed safety analysis for a demonstration AFMS, along with a discussion of results and conclusions to be included in subsequent Engineering Change Notice (ECN)’s dealing with AFMS core loadings.**

Discussion

- **Method of calculation was different compared to what was listed in the UFSAR**
- **Quality Assurance**
- **Verification and Validation**
- **Testing**

Summary

- **Three license amendment requests (LAR) were put in place by the NBSR, following the incident in February 2021 to enable the reactor to resume.**
- **Each LAR had different requirements in terms of analysis and documentation**
- **Best approach is *early and continuous engagement* with the regulator to resolve issues early on and reach a common understanding of expectations**

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QUESTIONS?