Finding of No Significant Hazard

December 23, 2021

In a license amendment request dated December 23, 2021, the NIST Center for Neutron Research (NCNR) requested an amendment to the facility license Technical Specifications (TS). As required by 10 CFR 50.91(a), the following analysis is presented to show the proposed amendment does not create a significant hazard using the criteria of 10 CFR 50.92(c).

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

No, the proposed amendment would not increase the probability or consequences of an accident previously evaluated. The proposed amendment provides redundancy in fuel latch verifications given in TS 3.9.2.1 and actually results in a decrease in probability of a fuel handling accident.

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

No, the proposed amendment would not create the possibility of a new or different kind of accident from any accident previously evaluated, as fuel movements and the mechanism of latching remain unchanged.

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

No, the proposed amendment would not involve a significant reduction in a margin of safety, as the amendment only concerns adding redundancy in fuel latch verifications.

3.9.2 Fuel Handling

3.9.2.1 Within the Reactor Vessel

Applicability: Fuel element latching

Objective: To ensure that all fuel elements are latched between the reactor grid plates.

Specifications

Following handling of fuel within the reactor vessel, the reactor shall not be operated until all fuel elements that have been handled are inspected to determine that they are locked in their proper positions in the core grid structure. This shall be accomplished by both of the following methods:

(1) Rotational check of the element head after final latching rotation by the refueling tool, followed by

(2) Visual inspection of the fuel element head or latching bar verifying that the element is in the latched position.

Basis

Each NBSR fuel element employs a latching bar, which shall be rotated to lock the fuel element in the upper grid plate. Following fuel handling, it is necessary to ensure that this bar is properly positioned so that an element cannot be lifted out of the lower grid plate, which will lead to a reduction in flow to the element after pump flow is initiated. Use of both methods above provides redundancy in verifying latching bar position. The visual inspection must follow the rotational check so that no tool would be subsequently used to inadvertently unlatch an element.

3.9.2.2 All Other Conditions

Applicability: Refueling system

Objective: To ensure the integrity of the fuel element cladding.

Description of tests in proposed changes to TS 3.9.2.1

Description of change

One of the root causes of the NBSR fuel failure event of February 3, 2021 was an inadequacy in the fidelity of latch determinations [1]. Corrective actions identified the need for improvements in latch verification methods and requiring both rotation and visual checks [2]. NBSR Technical Specification 3.9.2.1 currently requires a single latch verification by one of three ways: height check with flow, rotation check, or visual check. To codify the improvements for both rotation and visual checks, TS 3.9.2.1 is being modified to require both checks and eliminate the option for a height check with flow. A description of each of the required checks is below.

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^{o} 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. See Figure 1.

Prior to removal of the tool from the head, the azimuthal position of the collar affixed to the tool is checked against fiduciary marks on a sleeve inserted into the element position in the index plate. Figure 2 shows the rotational check on a fully latched element against a prototype sleeve that is slipped into the tooling plate and that has fiduciary marks indicating latched (green triangle) and fully unlatched (red triangle). These marks are true fiduciary marks in that they relate back to machined notches in the bottom of the tooling plate that are true to the cartesian axis system of the upper grid plate. Figure 3 shows the rotational check of the same element with the latch bar in a position that is still within the notch, but rotated in a clockwise direction. Note that, although latched, this element *would be assessed as unacceptable* and would need to be rotated so that the indication aligns with the green fiducial reference mark. Obviously, elements found rotated further clockwise (and likely out of the notch) would also be found unacceptable. Variations of rotation angles due to tolerances in the upper grid plate and notches are being evaluated and will be clearly indicated on future designs of the marked sleeve to give a clear “passing” criterion.

A detailed procedure, Operating Instruction (OI) 6.1.7, Rotational Latch Checks, using the new marked sleeve is being drafted and will be available on request.

Figure 1. Fuel element head latched into a mockup of the upper grid plate.

Figure 2. Fuel element latched in position H-7 (note: in this prototype the fully latched green triangle is about 2^{o} off of the actual fully latched position. This will be corrected in future prototype and design development.)

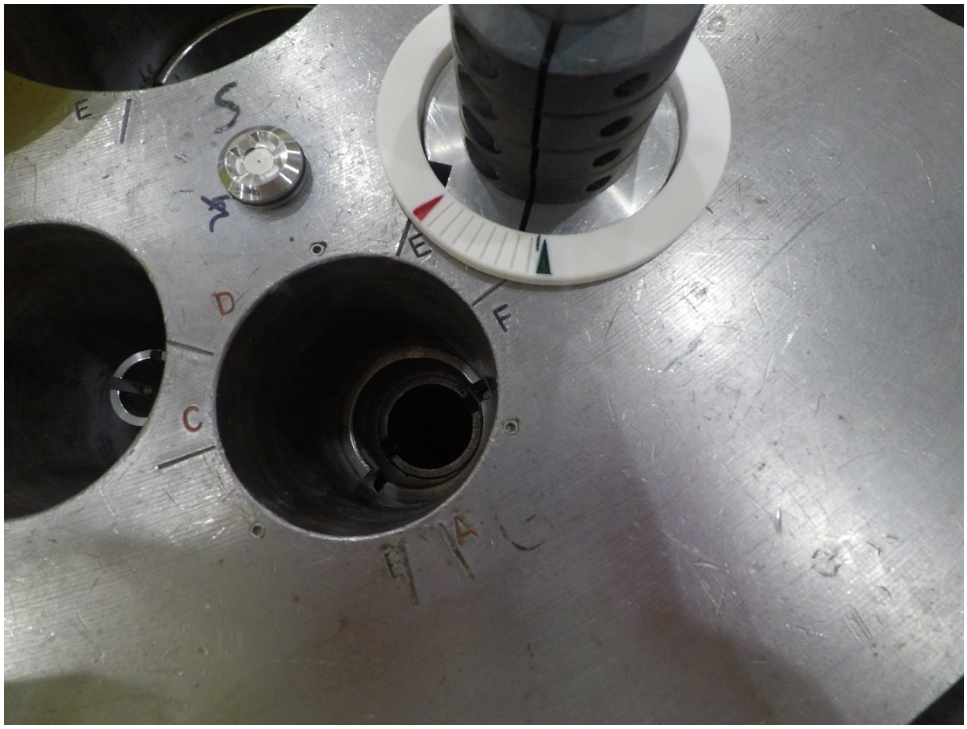

Figure 3. Fuel element in with latch about 6° off of full counterclockwise, but still in notch (H-7).

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 (As if one were introducing a fresh fuel element). This camera system is then systematically moved 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, will verify and document that each element is shown to be latched. A detailed procedure, Maintenance Procedure 5.39, Visual Check of Fuel Element Latch Bar, has been drafted and will be included in updated refueling procedures.

Photos of the video results of a test with a fully latched element in core position I-6 is shown in Figure 4. A photo of the H-7 element rotated about 6° off of full counterclockwise (the same as in Figure 3) is shown in Figure 5. The difference between the two can be easily seen, as the "ears" of the rotated element are clearly off perpendicular and would be rejected. Further rotation clockwise would also have the latch bar coming into view. As in the rotation check, evaluations are being made to clearly define acceptable visual check angle deviations.

Figure 4. Video capture of element in latched position (core position I-6)

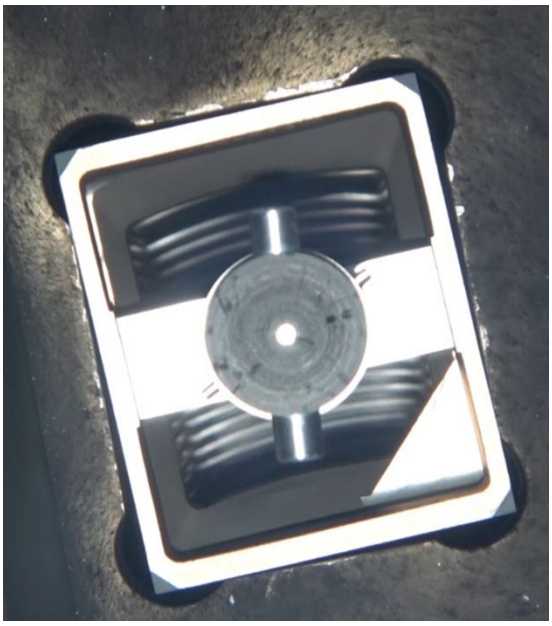

Figure 5. Video capture of element with latch rotated clockwise within the notch (core position H-7)

References

[1] NCNR Technical Working Group, “Root Cause Investigation of the February 2021 Fuel Failure” Revision 2, September 13, 2021.

[2] NCNR, “Root Cause Response” revision 1, September 20, 2021.