

Addendum to Root Cause Investigation of February 2021 Fuel Failure

NCNR Technical Working Group (TWG)

June 3, 2021

As part of the ongoing investigations of the February 2021 NCNR fuel failure, additional discoveries continue to be made beyond those which are described in the narrative given in the TWG Root Cause investigation (revision 1 dated May 13, 2021).

Video surveillances of latching and latch checks have revealed the possibility of inadvertently unlatching a fuel element by a relatively small impulse force from dropping the pickup tool onto the element head without any rotational force being applied. This was repeatedly demonstrated after discovery and was recorded on video.

Analysis of this phenomenon has shown that when the latch is moved to the fully latched position, the spring on the element head, in addition to elastic compression, stores further elastic energy in the form of elastic “windup”, or elastic torsion.* Thus, if the downward impulse from dropping the pickup tool is sufficient to push the latch out of the notch in the upper gird plate, the residual torque will move the latch towards the unlatched position (i.e. from where it came during the latching process) and, potentially all the way to fully unlatched (if all of the tool rotation remains stored in the spring as residual torque).

It is impossible to state categorically whether this caused the unlatched element leading to the February 3 event, but given the tool rubbing noted in the J-7 position during the January 4 refueling, it is likely that such an impulse may have occurred. This, combined with the improperly performed latch checks, offers a credible explanation of events.

Corrective Actions

An investigation (now assigned to CARRI team 5a) will be made as to the necessity and feasibility of a redesign of the element head spring mechanism. One concern is that adding complexity to the mechanism may create unintended consequences, so such a redesign must be carefully considered.

Root Cause Determination

Although this discovery offers a plausible explanation as to the direct cause of the event on February 3, the fundamental root causes discussed in the TWG Root Cause investigation remain unchanged.

*This elastic windup is made possible by the friction between the end-surfaces of the spring and the respective machine parts against which the spring develops a friction moment, that is proportional to the spring compression. It should be noted that here the descriptors “compression” and “torsion” are used with respect to the macroscopic outline of the spring, i.e., as if it were a tube (which it is not; it is a helix). So, these are not descriptors of the actual loading of the material of which the spring is made, which would be “torsion” and “bending” respectively.