

## **Nuclear Instrument Response**

As detailed in OI 1.1, reactor startup consists of power stops at 100 KW, 1 MW and 10 MW prior to ascension to full power. The stop at 10 MW requires the reactor operator to level at 10 MW for at least 5 minutes to look for “indications of an abnormal fuel element position as described in step 4.8.” Step 4.8 directs the reactor operator to shut down the reactor if “fluctuations or oscillations of two or more nuclear channels indications are significant or abnormal.” There are no criteria specified to determine whether any oscillations are seen as significant, it is left to the judgement of the reactor operator. Two previous instances of fuel elements being unlatched (1981 and 1993) showed power oscillations of 5-7% and on-the-job-training has been used to train some reactor operators to use this as an estimate for determining “significance”.

Figures 1 and 2 show traces that would have been seen by the reactor operator on a “normal” startup in December 2020, and that of February 3, which shows oscillations, but somewhat less than 5%. (note: the TWG root cause report stated oscillations of 1-2%. This was calculated using 10 second data taken from the recorders.) Also, for comparison is a normal operating trace of the recorder on the same resolution scale (Figure 3), and a plot with 5% oscillations and 7% oscillations, as would have been seen in previous events. Note that there is some statistical variation normally always seen, particularly at 10 MW and above. NIs at startup are at different levels due to shadowing of neutron beam shutters. Once the reactor reaches full power, these beam shutters are opened with the authorization of the reactor operator. After all shutters are opened, the NIs center closer to each other and are then adjusted based off a steady state thermal power calorimetric.

The operator on console (a Crew Chief with over 20 years’ experience) states that on February 3, that, during the 10 MW stop, there was a definitive determination by the operator and others in the control room at the time that the power trace was within normal limits. As a new regulating rod and controller had been installed earlier, the operator also considered that this might have the potential to affect oscillations.

Any changes in reactor plant conditions, such as installing a new regulating rod, will be included in the expanded change management framework which will include increased communications with operators of the effect of those changing conditions.

The corrective action of installing a noise gate on the Nuclear instrument channels (IE-SPI-1) will eliminate any subjective evaluation of whether oscillations are significant.

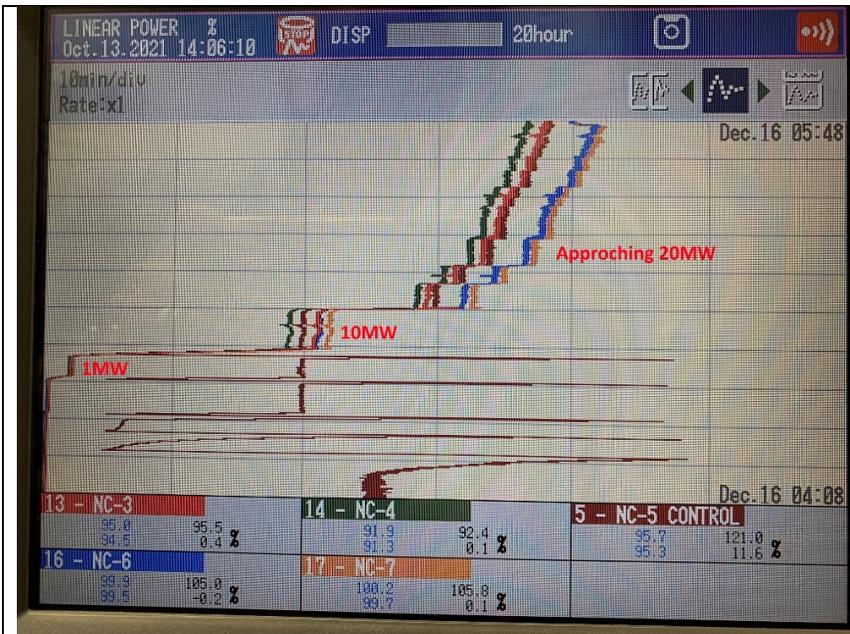


Figure 1. "Normal" startup on December 16, 2020.



Figure 2. Startup on February 3, 2021.

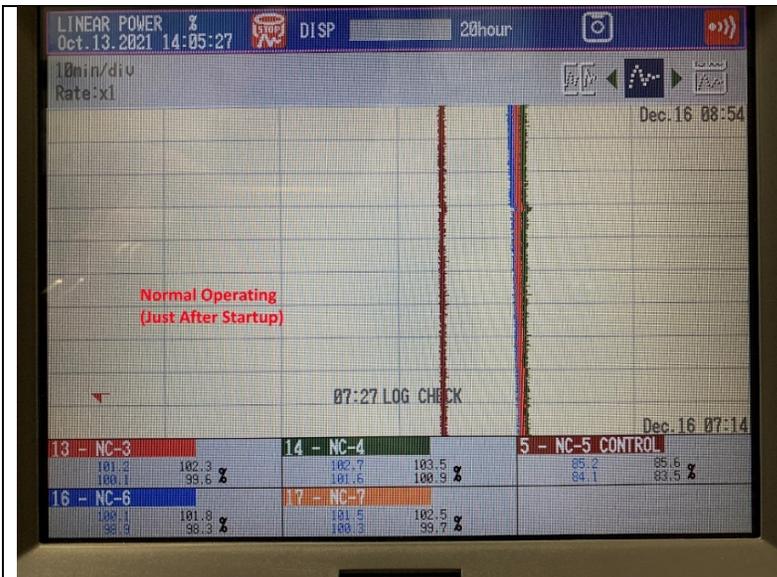


Figure 3. Normal operating trend

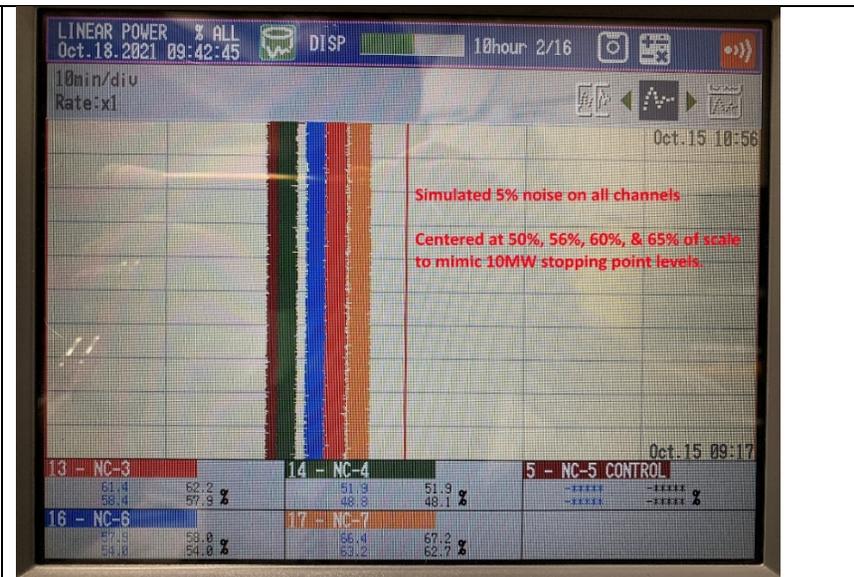


Figure 4. Simulated 5% variation

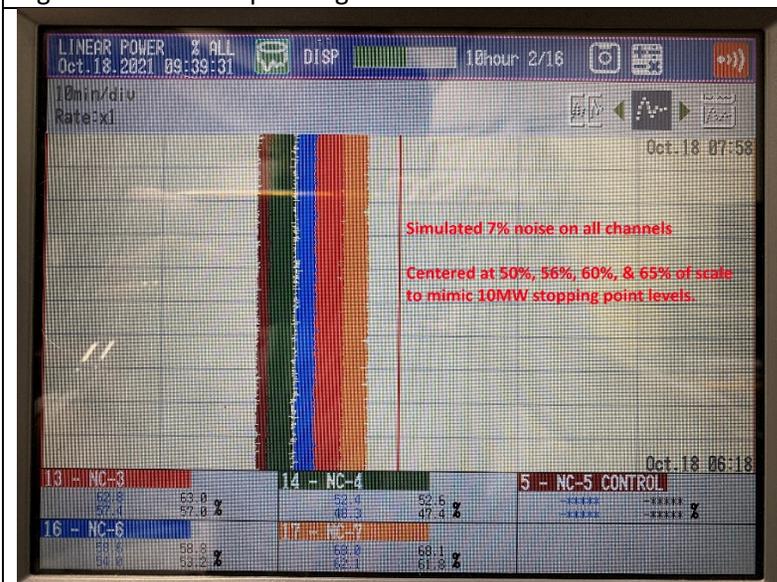


Figure 5. Simulated 7% variation

