Oregon State University

OSU Radiation Center

License Amendment Request to Remove Instrumented Fuel Element Requirements from Technical Specifications

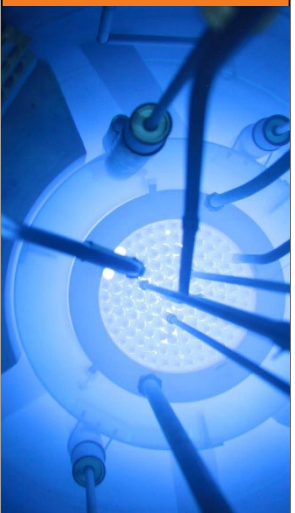
Robert Schickler
Steven Reese
Wade Marcum
Celia Oney

Oregon State University Radiation Center

March 18th, 2020

Oregon State University

OSU Radiation Center



Background

The Oregon State TRIGA® Reactor (OSTR) operations staff had a Phase Zero meeting with the NRC on 1/8/20 to discuss removing instrumented fuel element (IFE) requirements from the technical specifications in support of returning pulsing capabilities without IFE requirements.

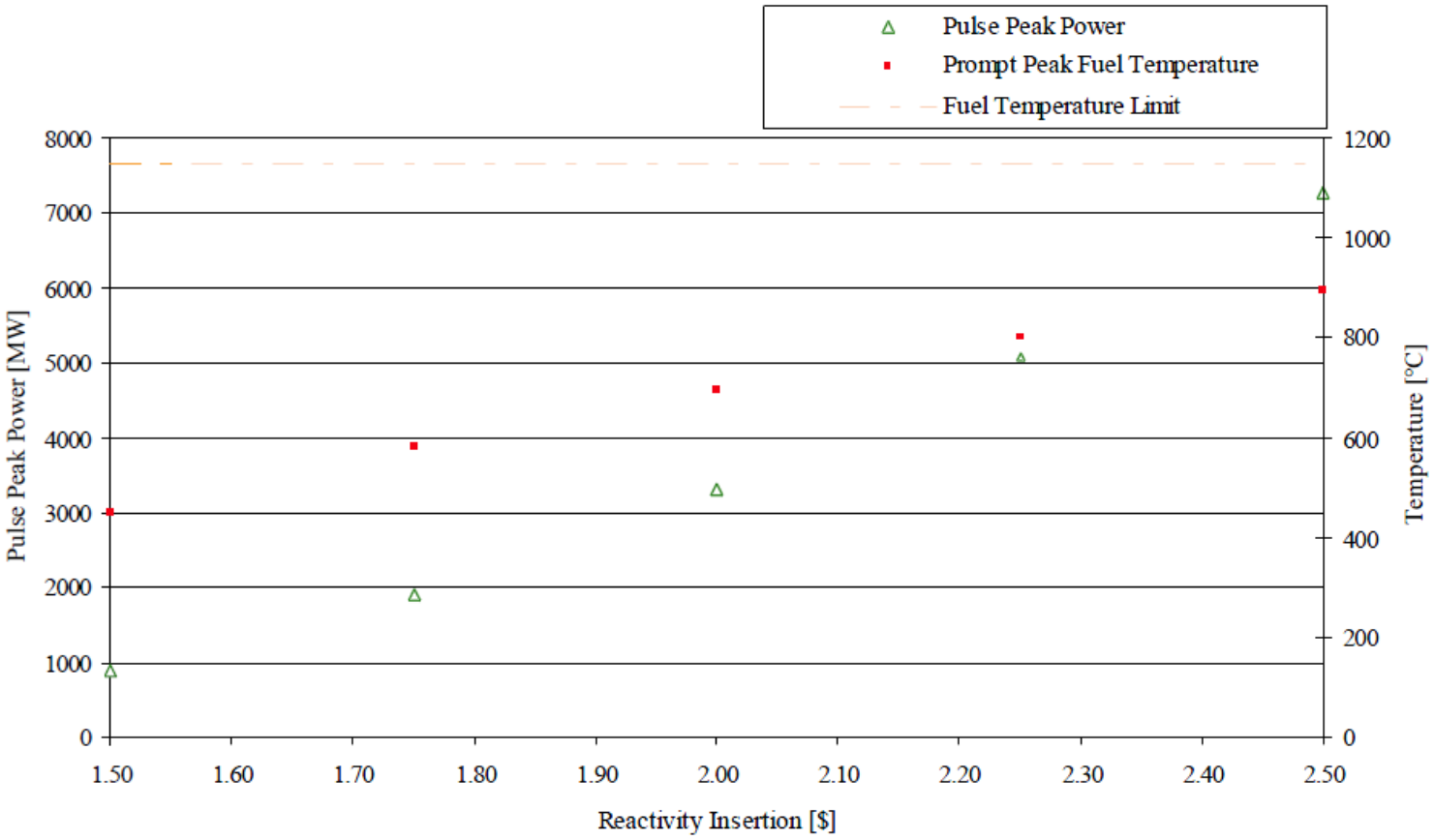
Questions were asked regarding the LEU conversion pulsing analysis.

Oregon State University

OSU Radiation Center

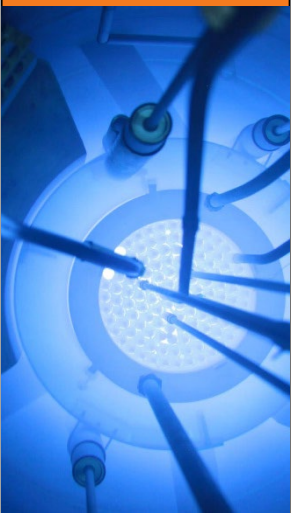
Conversion Pulse Analysis

Prompt peak fuel temperature is linear to reactivity. Interpolation shows that 830°C is exceeded at $2.33. Thus the reactivity limit for OSTR was set at $2.30.



Oregon State University

OSU Radiation Center



Uncertainty Analysis

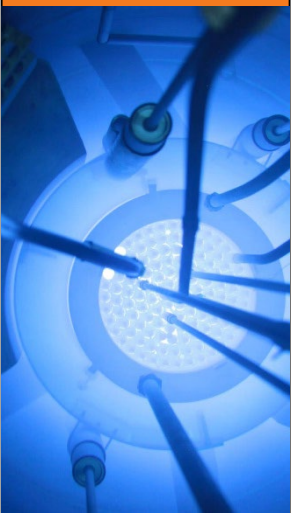
The NRC asked why there was no uncertainty stated in the thermal hydraulic analysis.

The analysis was performed in RELAP, a deterministic code that does not compute uncertainty.

The OSTR staff decided to review pulsing data to determine the uncertainty within actual pulse data.

Oregon State University

OSU Radiation Center



Test Pulse

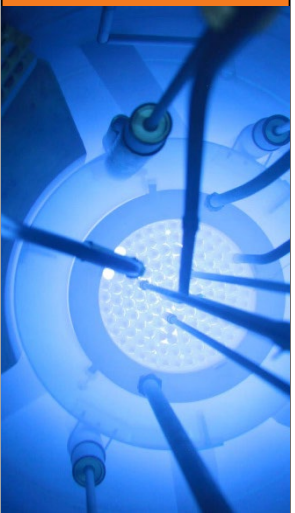
It was decided that the most consistent data to analyze was the OSTR test pulses. Per procedure, a $1.75 test pulse is performed every six months to determine how three key parameters change:

- Peak Temperature (in degrees C)
- Peak Power (in MW)
- Integrated Pulse Energy (in kW-hr)

These pulses are performed in a consistent manner, with a cold (room temperature), clean (xenon-free, Monday morning) core.

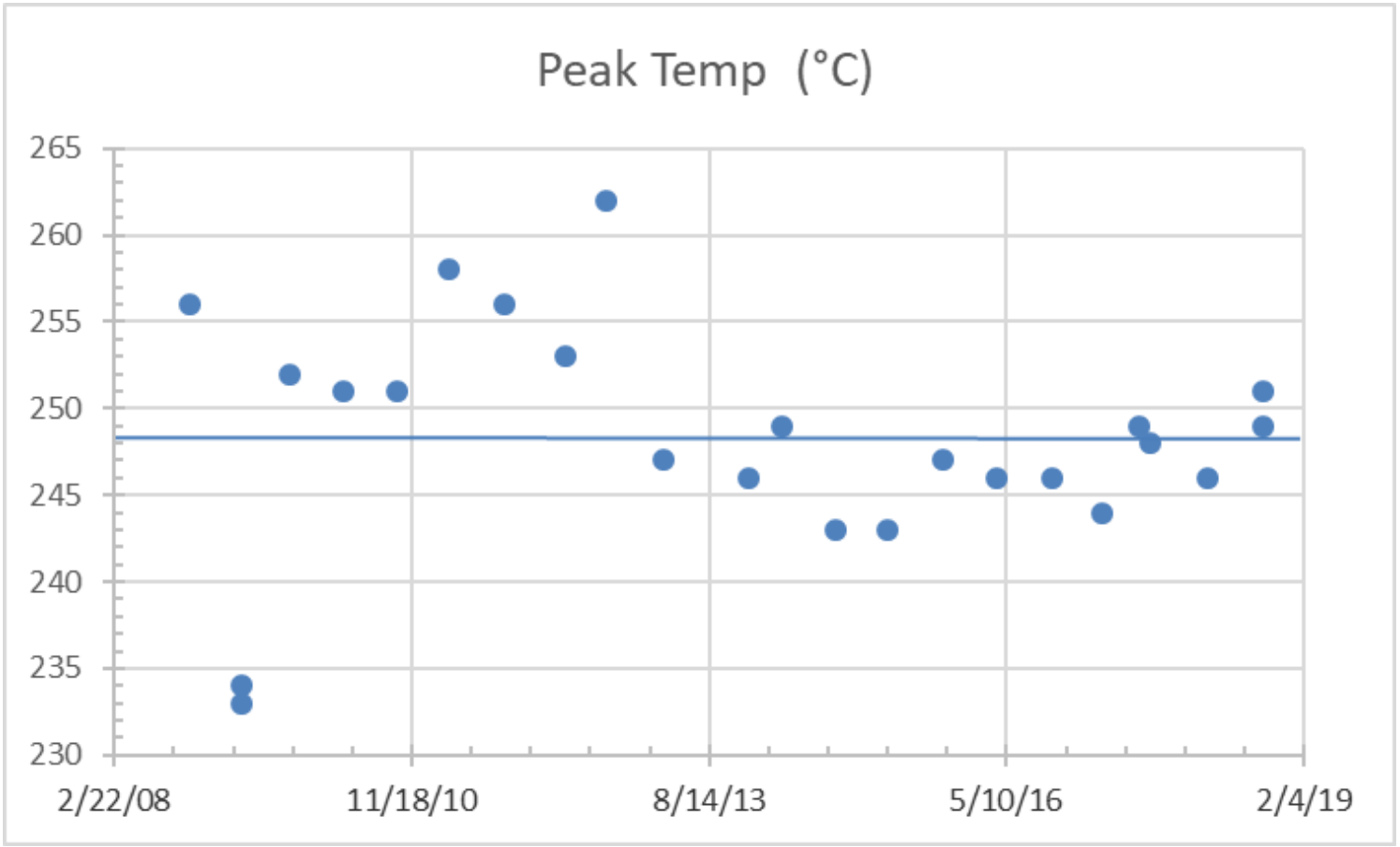
Oregon State University

OSU Radiation Center



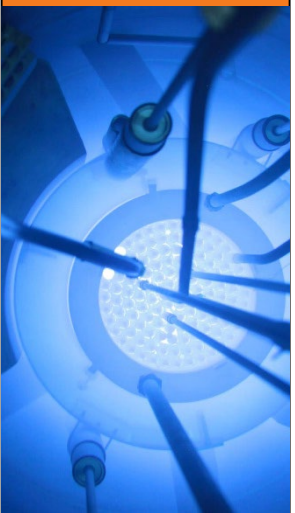
Peak Temperature of Test Pulses

This plot shows the peak temperature of $1.75 test pulses over the course of LEU fuel life (blue line = average).



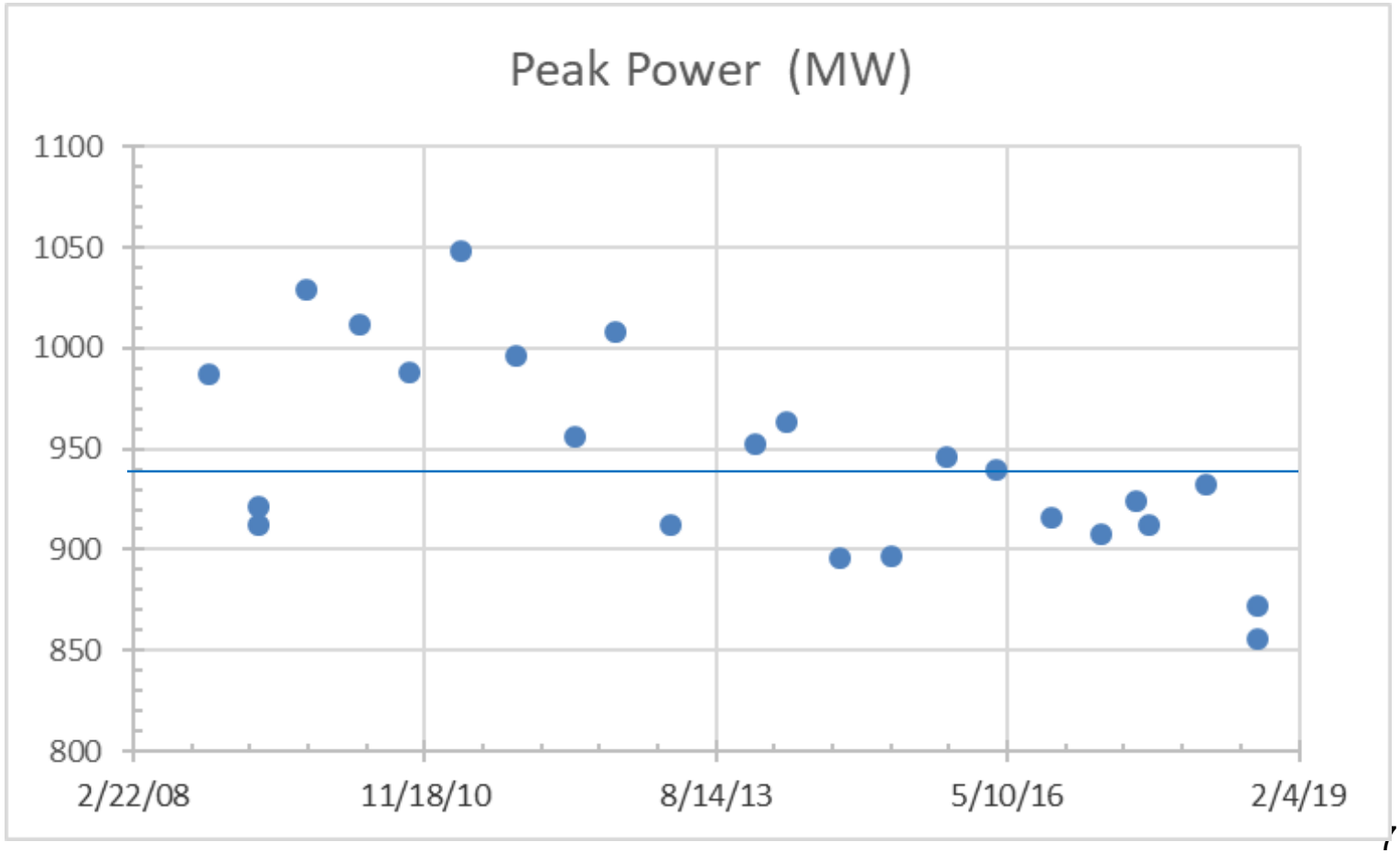
Oregon State University

OSU Radiation Center



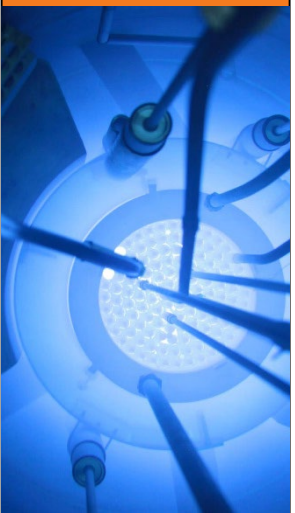
Peak Power of Test Pulses

This plot shows the peak power of $1.75 test pulses over the course of LEU fuel life (blue line = average).



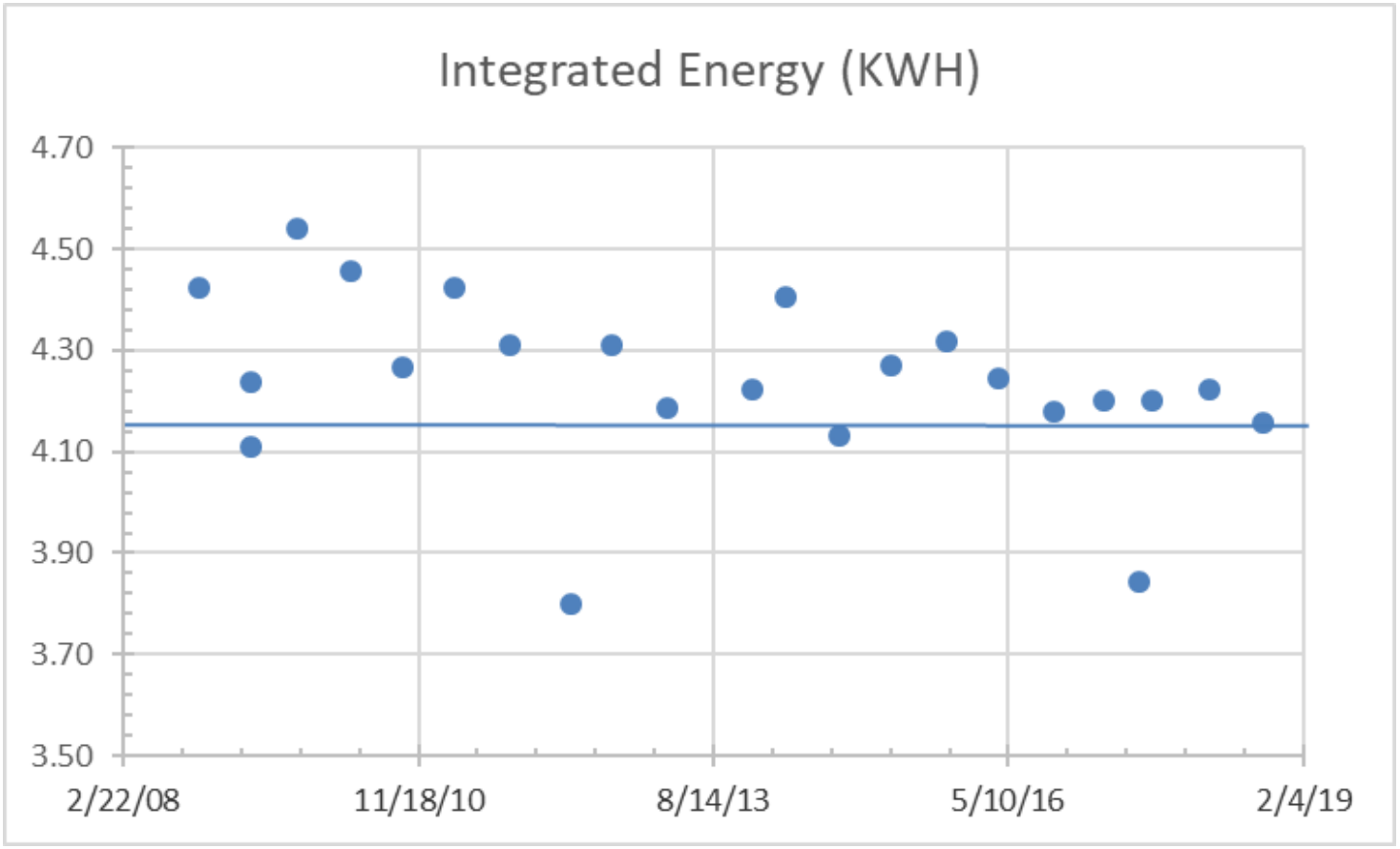
Oregon State University

OSU Radiation Center



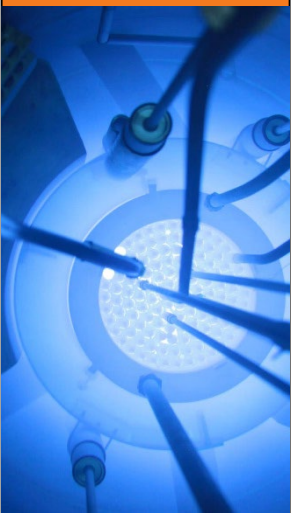
Integrated Energy of Test Pulses

This plot shows the integrated energy of $1.75 test pulses over the course of LEU fuel life (blue line = average).



Oregon State University

OSU Radiation Center



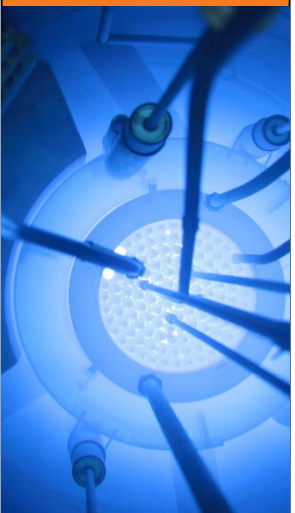
Analysis of Test Pulse Data

The following table shows the average of the three parameters (with 95% confidence) and how they compare to the maximum and minimum values.

	Peak Temp (°C)	Peak Power (MW)	Energy (KWH)
Average	248 ± 14	945 ± 100	4.237 ± 0.348
Max	262	1048	4.539
Min	233	856	3.800

Oregon State University

OSU Radiation Center



Further Analysis

OSTR realized that there was significant variance in the data from 2008-2013. This may be due to the previous reflector that was replaced in the summer of 2013. The reflector was replaced due to water in-leakage, which causes all gaps within the reflector can to fill with water.

This was not a trivial event. The entire core was defueled, ALL items were removed from the tank, the reflector core was replaced, and all items were reinstalled.

The water in-leakage may have caused some variance in the pulse data. The post-reflector data was further analyzed.

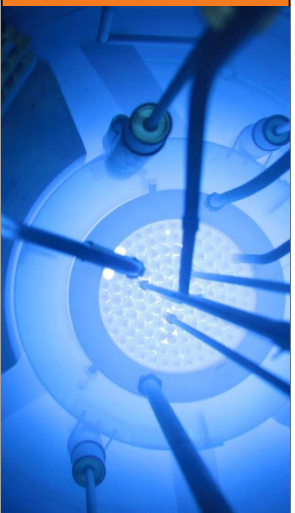
Oregon State University

OSU Radiation Center

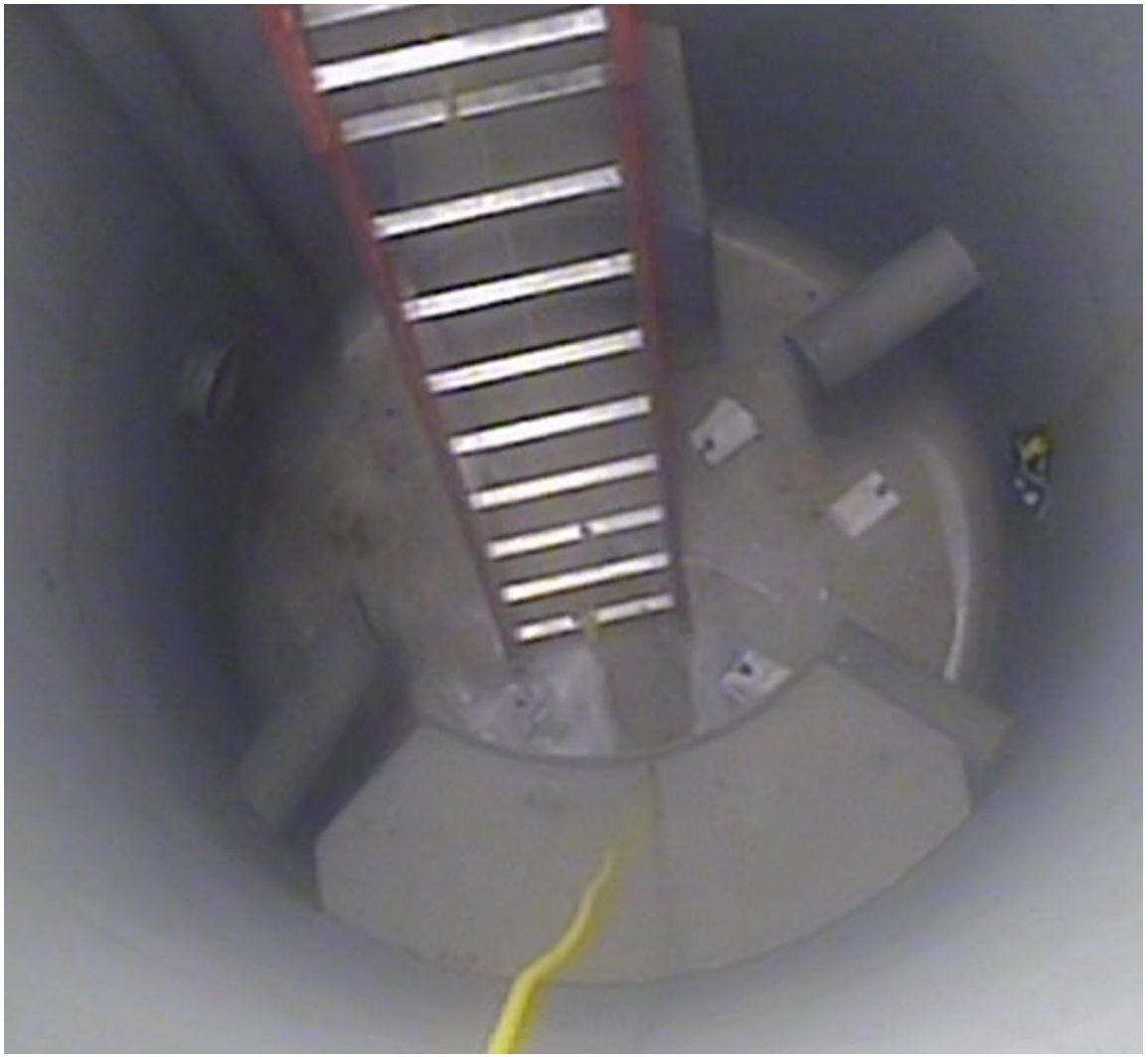
Removal of Original Reflector

Oregon State University

OSU Radiation Center



Empty Reactor Tank



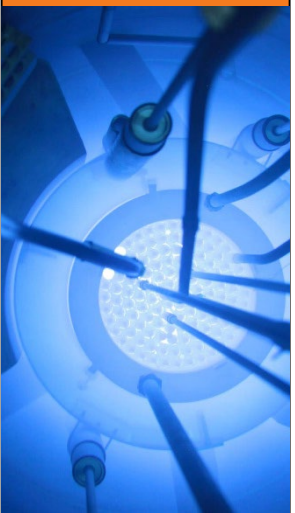
Oregon State University

OSU Radiation Center

Brand New Leak-Free Reflector

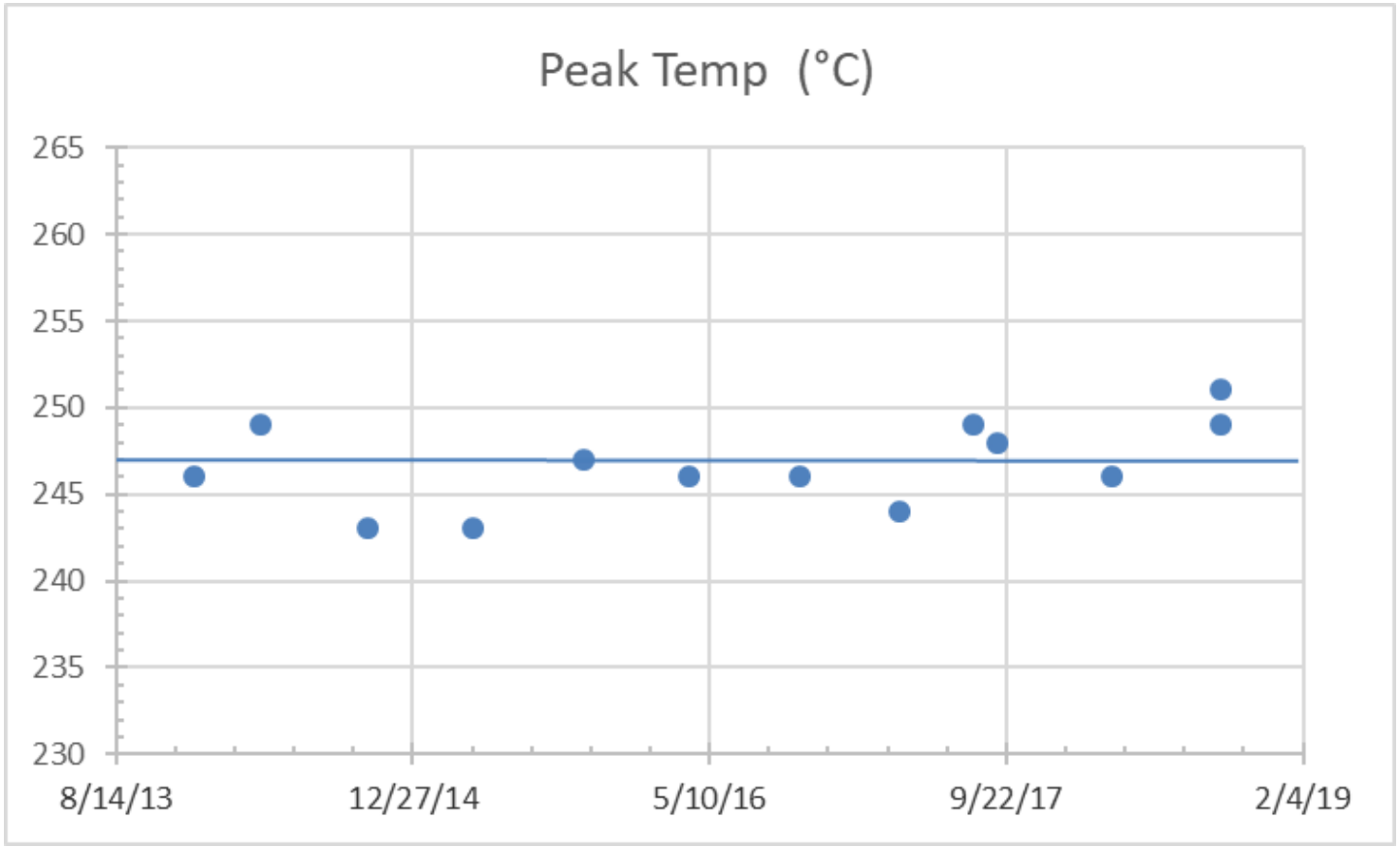
Oregon State University

OSU Radiation Center



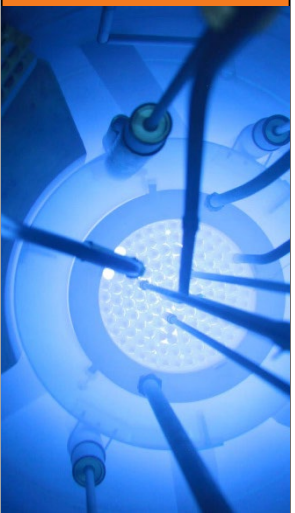
Peak Temperature of Post-Reflector Changeout Test Pulses

This plot shows the peak temperature of $1.75 test pulses post-reflector changeout (blue line = average).



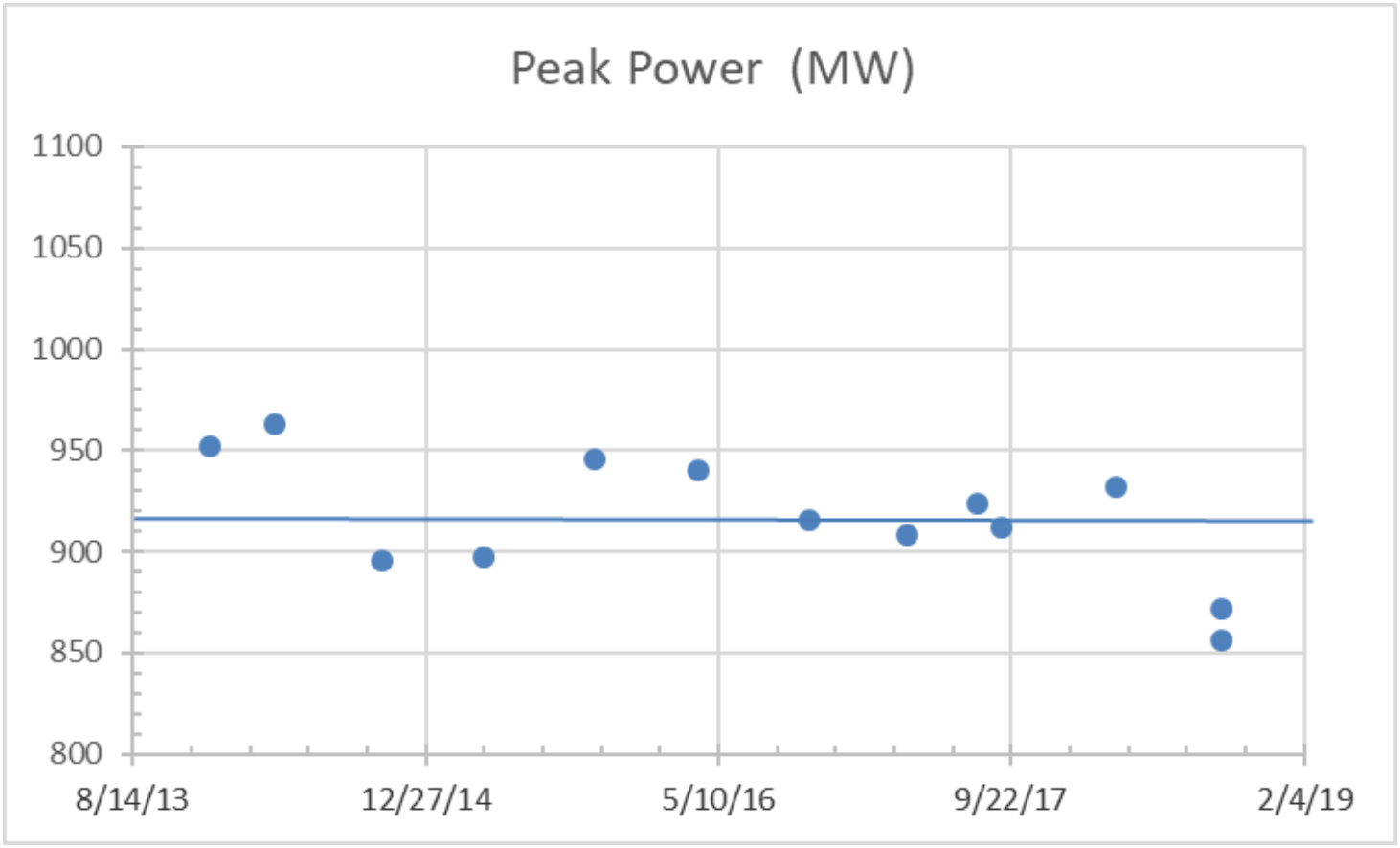
Oregon State University

OSU Radiation Center



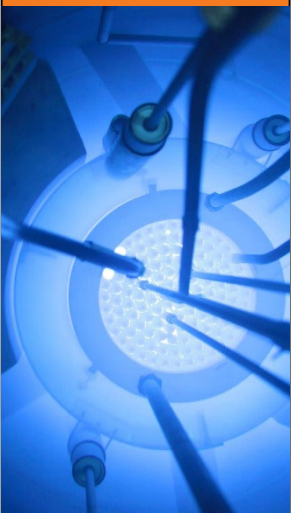
Peak Power of Post-Reflector Changeout Test Pulses

This plot shows the peak power of $1.75 test pulses post-reflector changeout (blue line = average).



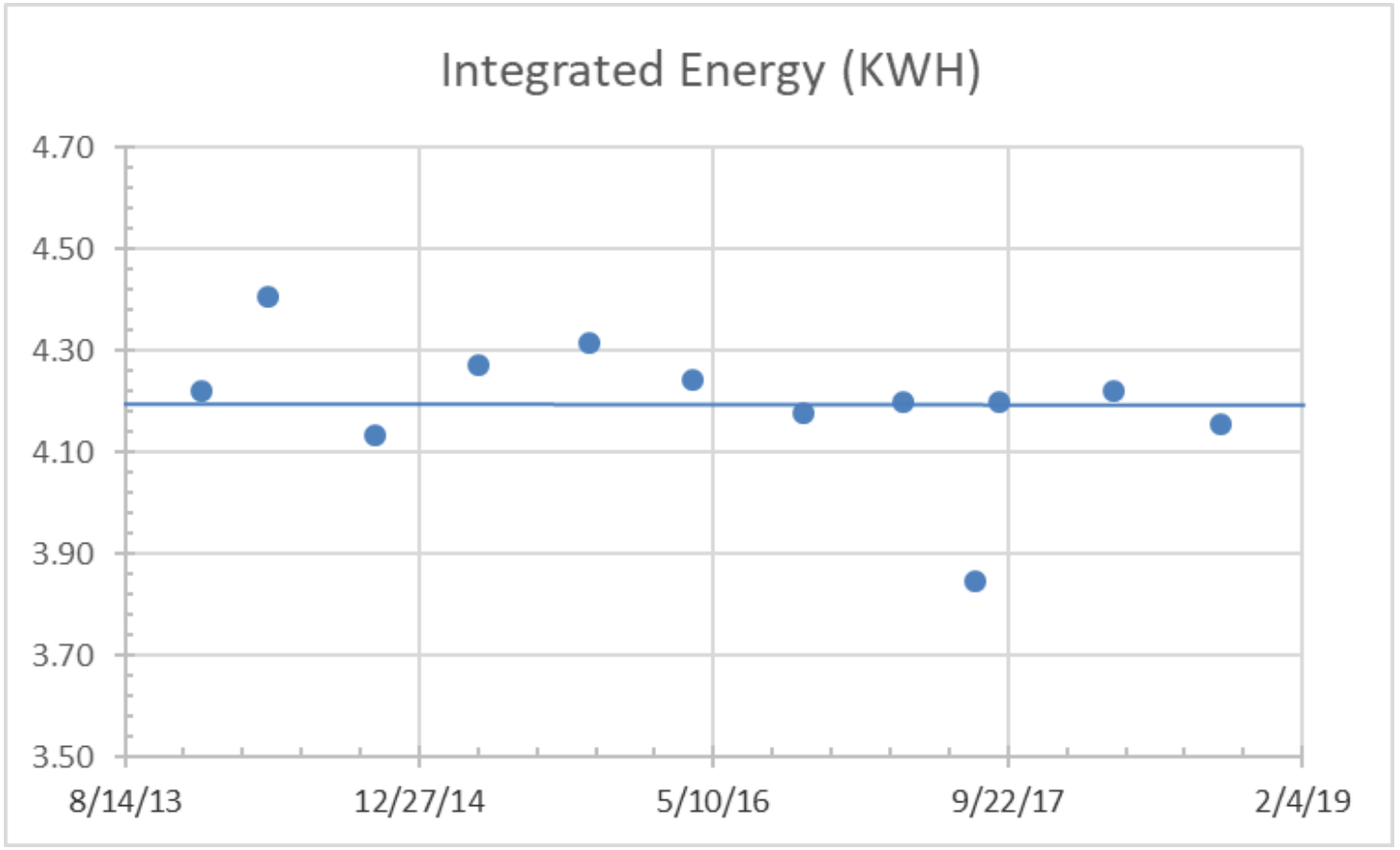
Oregon State University

OSU Radiation Center



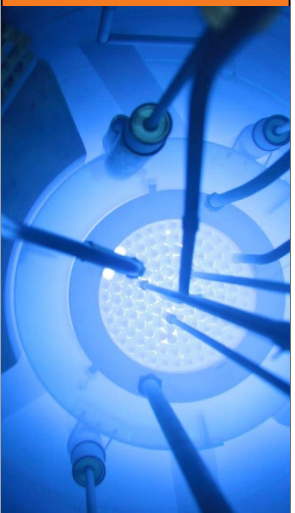
Integrated Energy of Post-Reflector Changeout Test Pulses

This plot shows the integrated energy of $1.75 test pulses post-reflector changeout (blue line = average).



Oregon State University

OSU Radiation Center



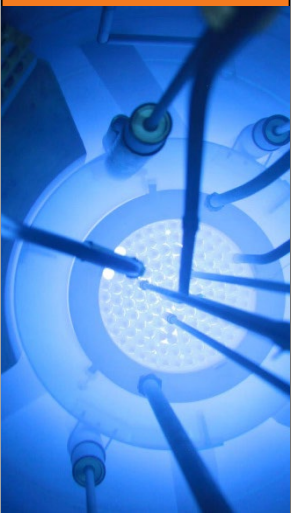
Analysis of Post-Reflector Changeout Test Pulse Data

The following table shows the average of the three parameters (with 95% confidence) and how they compare to the maximum and minimum values.

	Peak Temp (°C)	Peak Power (MW)	Energy (KWH)
Average	247 ± 4	916 ± 62	4.199 ± 0.268
Max	251	963	4.406
Min	243	856	3.844

Oregon State University

OSU Radiation Center



Conclusion

Over the last six years:

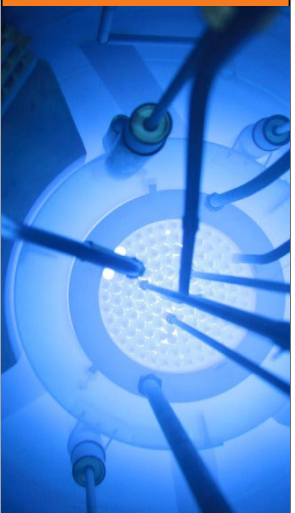
The IFE peak temperature results show a very minimal variance in pulse temperatures (less than 2%).

The peak power has a variance of approximately 7%.

The integrated energy has a variance of less than 8%.

Oregon State University

OSU Radiation Center

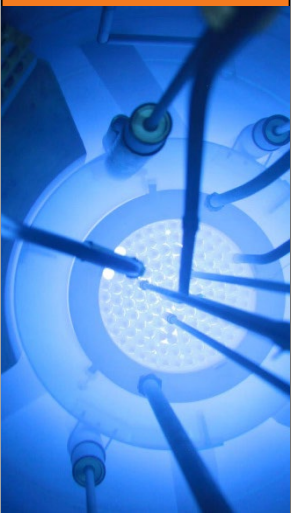


Proposed Technical Specification

The OSTR staff feels that the current technical specification of limiting pulses to temperatures not to exceed 830 C should be rewritten to be based upon reactivity limits. The current basis states that the reactivity should be limited to $2.30 and we believe the technical specification should be re-written as such and that the thermal hydraulic analysis is conservative enough to show that keeping reactivity insertions below this limit will permit safe pulsing of the OSTR.

Oregon State University

OSU Radiation Center



Questions?