ABSTRACT: The United States Geological Survey TRIGA Reactor (GSTR) is a 1 MW reactor located in Lakewood Colorado. In support of the GSTR’s relicensing efforts, this project developed and validated a Monte Carlo N-Particle Version 5 (MCNP5) model of the GSTR reactor. The model provided estimates of the excess reactivity, power distribution and reactivity coefficients for the current and limiting core for the fuel temperature, water temperature, void, and power. Following the neutronics analysis, the project developed RELAP5 and PARET-ANL models of the GSTR hot-rod fuel channel under steady state and transient conditions. The GSTR limiting core, determined as part of this analysis, provides a worst case operating scenario for the reactor. The model predicts a limiting core excess reactivity of $6.48 with a peak rod power of 22 kW. The fuel and void reactivity coefficients for the limiting core are strongly negative, and the core water reactivity coefficient is slightly positive, consistent with other TRIGA analyses. The average fuel temperature reactivity coefficient is -0.0135 $/K while the average core void coefficient is -0.069 $/K from 0-20 % void. The core water temperature reactivity coefficient is +0.008 $/K. During steady state operations, the hot rod of the limiting core has a peak fuel temperature of 829 K and a minimum departure from nucleate boiling ratio of 1.45. After a $3.00 pulse reactivity insertion the peak fuel temperature is 1104 K. During an uncontrolled rod withdrawal, the reactor reaches a peak rod temperature of 347 zk, representing a temperature rise of 13 K from the initial conditions. Examining the model results several seconds after a pulse reveal flow instabilities that result from weaknesses in the current two-channel model.