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#04-196 Summary of Thermocouple Performance in the Advanced Gas Reactor Experiment AGR-5/6/7 During Irradiation in the Advanced Test Reactor

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The Advanced Gas Reactor -5/6/7 (AGR-5/6/7) experiment was the fourth and final experiment in the AGR experiment series and completed irradiation in July 2020. It serves as the formal fuel qualification test for the TRISO fuels under development by the US Department of Energy. This experiment was designed to irradiate fuel particles at temperatures ranging from 800℃ –1500℃. The high end of the range created unique challenges for thermocouple-based temperature measurements. Commercially available high-temperature platinum-rhodium thermocouples (Types S, R, and B) and tungsten-rhenium thermocouples (Type C) suffer rapid decalibration due to transmutation of the thermoelements from neutron absorption. A special low neutron cross-section thermocouple system based on molybdenum/niobium thermoelements called High Temperature Irradiation Resistant thermocouple (HTIR-TC) has been under development at INL since circa 2004. Several examples of this thermocouple type were incorporated into regions of the test operating above 1200℃. For regions in the test operating in the 1000℃ –1200℃ range, high-performance versions of Type N thermocouples recently developed at Cambridge University were installed. Standard Type N thermocouples were used in regions of the test operating below 1000℃. A total of 54 thermocouples were incorporated into the test. A report of the performance of this large heterogenous set of thermocouples over the first third of the irradiation was previously provided (ANIMMA 2019). This follow-on paper discusses results from the balance of the experiment (Feb 2019 –July 2020). Special attention is focused on the estimated drift of thermocouples operating in the higher temperature regions. This is particularly important as an input to the final irradiation report for AGR-5/6/7, in which estimates are presented of the temperature distribution of the 570,000 particles irradiated.

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