Abstract: Advancements in high-temperature fluid advanced reactors (AR), such as sodium-cooled fast reactors (SFRs) and molten salt cooled reactors (MSCRs), involve development of novel sensing technologies to enable AR autonomous operation and minimization of operation and maintenance costs. A promising instrumentation approach for ARs consists of distributed fiber optic sensors (DFOS). Compared to conventional thermocouple sensors, DFOS obtains information about temperature field in the fluid with minimal number of physical sensor units and penetrations through pressure boundaries. Temperature sensing with Rayleigh backscattering DFOS consists of measuring optical frequency shift due to intrinsic scattering impurities in the silica glass of the fiber, which is converted to temperature values using a calibration curve. For deployment of DFOS in ARs, it is important to develop methods for improving accuracy of DFOS temperature measurements. In this work, we apply Bayesian inference **method** for calibration and uncertainty quantification of Rayleigh scattering DFOS. Experimental data for this work is obtained from DFOS and thermocouple measurements in a water flow loop with a thermal mixing tee. By integrating prior knowledge and current observations, Bayesian methods were employed to refine the correction that converts measured frequency **shift** in the fiber to temperature values. The Delayed Rejection Adaptive Metropolis (DRAM) algorithm was used to determine the posterior distributions, achieving optimized parameter estimation evidenced by satisfactory Geweke diagnostic scores. Results from this research demonstrate that Bayesian calibration significantly improves the accuracy of temperature measurements with DFOS.