The virial equation of state (VEOS) is a power series in density, with coefficients that can be determined from molecular considerations. Its rigorous connection to statistical mechanics makes it an appealing choice for many purposes, but its utility is limited to conditions where the series converges. Singular behavior in the equation of state, such as encountered upon approach to the critical point, restricts its range of application. In previous work, we took steps to address this problem by forming an approximant that explicitly incorporates this singular behavior while remaining fully consistent with the VEOS at low density. This treatment was shown to provide several new capabilities, including improved predictions of critical properties from the virial coefficients, refinement of critical properties given by simulation/experimental measurements, and an estimate of a critical amplitude for several fluids. Our previous work was restricted to the critical isotherm. In the present work, we enhance the approximant by including temperature dependence, allowing us to incorporate scaling along the critical isochore. The approximant is designed to enforce the correct singular behavior at the vapor-liquid critical point, while still retaining the correct temperature-dependent low-density behavior as expressed by the VEOS. The efficacy of the proposed equation of state is demonstrated for the square-well fluid, chosen for this initial study because the temperature dependence of its virial coefficients can be expressed analytically.