Spectroscopic and Magnetic Susceptibility Analyses of the $^7F_J$ and $^5D_4$ Multiplet Manifolds of Tb$^{3+}$ (4f$^8$) in TbAlO$_3$ KELLY NASH, JOHN GRUBER, DHIRAJ SARDAR, University of Texas at San Antonio, UYGUN VALIEV, ABDULLA UZOKOV, National University of Uzbekistan, GARY BURDICK, Andrews University — Detailed analyses of temperature-dependent spectroscopic and magnetic susceptibility data are reported for the crystal-field split energy levels of the $^7F_J$ and $^5D_4$ of Tb$^{3+}$ TbAlO$_3$. The spectroscopic data include absorption spectra obtained between 480 and 2940 nm from 8 to 300 K. High resolution fluorescence spectra are reported, representing transitions from $^5D_4$ to $^7F_{6,5,4}$, at a sample temperature of 85 K. Using crystal-field modeling techniques recently adapted for low symmetry systems, we have assigned all 58 experimental Stark levels within the $^7F_J$ and $^5D_4$ manifolds, with a fitting standard deviation of 4.5 cm$^{-1}$ (3.8 cm$^{-1}$ rms error). Furthermore, the theoretical Stark levels and calculated wavefunctions were used to determine the temperature dependence of the magnetic susceptibility along the $c$-axis of the TbAlO$_3$ crystal. Agreement is obtained between the calculated susceptibility and temperature-dependent magnetic data reported earlier. The susceptibility calculation also confirms the predicted ordering of states within the $^7F_6$ multiplet manifold.