The evolution in microstructural and mechanical properties was investigated for molybdenum and molybdenum alloys after high temperature neutron irradiation. Test materials include oxide dispersion-strengthened (ODS) molybdenum alloy, molybdenum-0.5% titanium-0.1% zirconium (TZM) alloy, and low carbon arc-cast (LCAC) molybdenum. Tensile specimens were irradiated in high flux isotope reactor (HFIR) at temperatures in the range ∼300 - 1000 °C to neutron fluences of 2.28 - 24.7 \times 10^{25} \text{n/m}^2( E > 0.1 \text{ MeV}) or 1.2 -13.1 dpa. Tensile tests were performed at temperatures ranging from -150 °C to 1000 °C. To evaluate irradiation effects, true stress parameters (yield stress, plastic instability stress, and true fracture stress) and ductility parameters (uniform strain, fracture strain, and reduction area) were compared for both irradiated and non-irradiated materials. Fracture toughness was also evaluated from the fracture stress and fracture strain data using a fracture strain model. The fracture strain was used to determine the ductile-to-brittle transition temperature (DBTT). Results indicate that irradiation in the temperature range of 600 - 800 °C hardened the materials by up to 70%, while the irradiation hardening outside this temperature range was much lower (<40%). The plastic instability stress was strongly dependent on test temperature; however, it was nearly independent of irradiation dose and temperature. It was also found that the true fracture stress was dependent on test temperature. The true fracture stress was not significantly influenced by irradiation at elevated and high test temperatures; however, it was decreased significantly at subzero temperatures after irradiation due to material embrittlement. The DBTT for 600 °C irradiated ODS molybdenum alloy was found to be about room temperature or lower, and among the test materials the ODS alloy showed the highest resistance to irradiation embrittlement. The as-irradiated and deformed microstructures were characterized by TEM and compared to explain the high toughness behavior of the ODS alloy.