A transition from petroleum-derived jet fuels to blends with Fischer–Tropsch (F-T) fuels, and ultimately fully synthetic hydro-isomerized F-T fuels has raised concern about the fate of plasticizers in nitrile-butadiene rubber o-rings that are contacted by the fuels as this transition occurs. The partitioning of plasticizers and fuel molecules between nitrile o-rings and petroleum-derived, synthetic, and additized-synthetic jet fuels has been measured. Thermal desorption of o-rings soaked in the various jet fuels followed by gas chromatographic analysis with a mass spectrometric detector showed many of the plasticizer and stabilizer compounds were removed from the o-rings regardless of the contact fuel. Fuel molecules were observed to migrate into the o-rings for the petroleum-derived fuel as did both the fuel and additive for a synthetic F-T jet fuel additized with benzyl alcohol, but less for the unadditized synthetic fuel. The specific compounds or classes of compounds involved in the partitioning were identified and a semiquantitative comparison of relative partitioning of the compounds of interest was made. The results provide another step forward in improving the confidence level of using additized, fully synthetic jet fuel in the place of petroleum-derived fuel.