A local short-to-intermediate range order of liquid Al$_{80}$Co$_{10}$Ni$_{10}$, Al$_{72.5}$Co$_{14.5}$Ni$_{13}$, and Al$_{65}$Co$_{17.5}$Ni$_{17.5}$ alloys was examined by X-ray diffraction and the reverse Monte Carlo modelling. The comprehensive analysis of three-dimensional models of the liquid ternary alloys was performed by means of the Voronoi-Delaunay method. The existence of a prepeak on the $S(Q)$ function of the liquid alloys is caused by medium range ordering of 3$d$-transition metal atoms in dense-packed polytetrahedral clusters at temperatures close to the liquidus. The non-crystalline clusters, represented by aggregates of pentagons that consist of good tetrahedra, and chemical short-range order lead to the formation of the medium range order in the liquid binary Al-Ni, Al-Co and ternary Al-Ni-Co alloys.

**Key words:** High-Temperature Alloys; Atomic Scale Structure; X-Ray Diffraction; Computer Simulations; Prepeak.