Advanced microstructure characterisation and microstructure modelling has demonstrated that long-term microstructure stability in 9–12% Cr steels under technical loading conditions is equivalent to precipitate stability. Mo and W can have a positive influence on long-term creep strength of 9–12% Cr steels by Laves phase precipitation hardening. Unexpected breakdown of long-term creep stability of a number of alloys is caused by precipitation of the complex Z-phase nitride, which may completely dissolve fine V and Nb containing MX nitrides. High Cr contents of 10% and above in the steels accelerate Z-phase precipitation.