The purpose of this document is to summarize the work done in the workpackage 4 of the IDEAL (Integrated Development Routes for Optimized Cast Aluminium Components) project, financed by the EU in frame work 6 and born in collaboration with the automobile and foundry industries. The objective of this workpackage is to simulate creep behavior of aluminum cast samples subjected to high temperature. In this document a two-state variables unified model is applied in order to simulate creep behavior and time-dependent metallurgical changes. The fundamental assumption of the unified theory is that creep and viscoplasticity, which are both irreversible strains developed because of dislocations motion in the material structure, can be modelled through the implementation of a similar plastic strain velocity law, generally called flow rule.

The document shows how to obtain the material data needed for the simulation of the stress-strain behavior of aluminum at high temperature. As an example, the analysis of several tests performed at various temperatures and strain rates on a particular aluminum alloy, is presented as well. Furthermore, the one dimensional code developed during this project is illustrated and a simulation is run using the material data obtained through the mentioned experimental study. The results obtained for the simulation of tensile tests and of creep tests are compared with experimental curves, showing a good agreement. Moreover, the document describes the results obtained during the first implementation of a three-dimensional code, both on a simple geometry, i.e. a bar, as well as on a more complex geometry, i.e. stress lattice, during the simulation of the solidification phase. Even though no experimental results were available for a comparison, the simulations show that the numerical program is quite stable and convergence can be reached also with big time steps.

Keywords: Viscoplasticity, creep, unified constitutive model, aluminum, high temperature.