Characterization of Implicit LES Methods ANDREW ASPDEN,
Lawrence Berkeley National Laboratory — The broad range of time and length
scales present in high Reynolds number turbulent flows is often prohibitively ex-
ensive for direct numerical simulations (DNS) to capture completely. Large eddy
simulation (LES) attempts to circumvent this issue by filtering out the small scale
motions in the flow, replacing their effects with a subgrid model. High-order finite-
volume schemes can accurately capture the inviscid cascade of kinetic energy, and
the inherent truncation error acts as an implicit subgrid model, forming a natural
form of LES. However, the absence of a physical viscosity prohibits conventional
characterization of these methods, specifically how kinetic energy is dissipated at
the grid scale and how to define a relevant Reynolds number. Kolmogorov’s 1941
papers achieve this characterization for real-world viscous fluids in terms of a uni-
versal equilibrium range determined uniquely by the rate of energy dissipation and
physical viscosity. Analogously, this paper proposes than an ILES method can be
characterized by a universal equilibrium range determined uniquely by the energy
dissipation rate and computational cell width. Implicit LES simulations of main-
tained homogeneous isotropic turbulence are presented to support this proposal and
highlight similarities and differences with real-world viscous fluids. Direct compar-
ison with data from high resolution DNS calculations provides a basis for deriving
an effective viscosity and an effective Kolmogorov length scale.

Andrew Aspden
Lawrence Berkeley National Laboratory

Date submitted: 03 Aug 2007

Electronic form version 1.4