Part III
Interaction and Fluid-Mechanical Processes

In gas turbine combustors, the thermal load of combustor walls in terms of wall temperature profiles represents an important aspect of the total combustor concept. Its correct capturing is essential, bearing in mind that the efficiency and longevity of the gas turbine are strongly dependent on the maximum temperature, which a combustor wall can withstand. The characteristics of turbulent flow adjacent to the solid boundaries differ substantially from those accounted in the core region as investigated in the other parts of this book. This relates primarily to the enhanced viscosity influence but also to the non-viscous wall-blockage effects expressed in terms of both Reynolds stress and stress dissipation anisotropies. In the high-temperature reactor cases the steep temperature gradients due to wall heating have also to be accounted for. The most important variations of the fluid properties, i.e. viscosity and density, are concentrated in the immediate wall vicinity. The strongest modification of the flow structure occurs in the inner part of the temperature layer. All these features, especially in conjunction with phenomena, such as swirl and separation, invalidate the use of the wall models based on the assumptions of a local equilibrium. Correct capture of these phenomena can be achieved only by integration of the governing equations up to the wall using the exact boundary conditions.

Chapter 9 proposes a solution for both the physical modeling and numerical implementation of the wall-boundary conditions. This should permit the advantageous use of the second-moment and related turbulence closures within RANS and Hybrid LES/RANS frameworks for prediction of flows near solid boundaries for complex and technically relevant applications. The feasibility of the methods is illustrated in various wall-bounded turbulent flows also associated with scalar transport under constant and variable property conditions.