Significant dynamic forces can be generated by annular seals in rotordynamics and can under certain conditions destabilize the system leading to machine failure. Mathematical modelling of dynamic seal forces are still challenging, especially for multiphase fluids and for seals with complex geometries. This results in much uncertainty in the estimation of the dynamic seal forces which often leads to unexpected system behaviour. This paper presents the results of a method suitable for on-site identification of uncertain dynamic annular seal forces in rotordynamic systems supported by Active Magnetic Bearings (AMB). An excitation current is applied through the AMBs to obtain perturbation forces and a system response, from which, the seal coefficients are extracted by utilizing optimization and a-priori information about the mathematical model structure and its known system dynamics. As a study case, the method is applied to a full-scale test-facility supported by two radial AMBs interacting with one annular center mounted test-seal. Specifically, the dynamic behaviour of a smooth annular seal with high preswirl and large clearance is investigated in this study for different excitation frequencies and differential pressures across the seal. The seal coefficients are extracted and a global model on reduced state-space modal form are obtained using the identification process. The global model can be used to update the model based controller to improve the performance of the overall system. This could potentially be implemented in all rotordynamic systems supported by AMBs and subjected to seal forces or other fluid film forces.