A mathematical model is developed to simulate the interaction of an isolated operating sprinkler and a two-layer fire environments under arbitrary conditions of sprinkler-nozzle elevation, and upper- and lowerlayer thickness and temeperature.

The sprinkler is characterized by water flow rate, nozzle diamteter, and three other device parameters. The model takes account of all effects of the sprinkler spray as it entrains, drives downward (by aerodynamic drag on the spray drops), humidifies, and cools (bydrop evaporation) gases from both the high temperature upper layer and the relatively cooler lower layer. The model provides a means of predicting the rates of flow of mass, enthalpy, products of combustion, and evaporated water to each of the two layers as a result of sprinkler operation.

An algorithm for such predictions is presnted in a manner that is suitable for general use in two- layer zone-type compartment fire models. The model is exercised in example calculations which simulate the interaction between the spray of a real sprinkler device and both fire and non-fire environments.

The calculations revealed an important generic interaction phenomenon, namely, an abrupt and large change in the growth rate of an upper layer that would accompany an increase in upper layer thickness beyond a critical thickness (for a given upper layer temperature) or an increase in upper layer temperature beyond a critical temperatur (for a given upper layer thickness). Exceeding critical values would lead to very large rate of growth of upper layer thickness, a growth that would likely lead to rapid and complete smoke filling of even the largest compratments of fire origin.