Increasing attention is being devoted to the airborne emissions resulting from a variety of manufacturing processes because of health, safety, and environmental concerns. In this two-part paper, a model is presented for the amount of cutting fluid mist produced by the interaction of the fluid with the rotating cylindrical workpiece during a turning operation. This model is based on relationships that describe cutting fluid atomization, droplet settling, and droplet evaporation. Experiments are performed to validate the model. In Part 1 of the paper, the emphasis is on model development. In the model, thin film theory is used to determine the maximum fluid load that can be supported by a rotating cylindrical workpiece; rotating disk atomization theory is applied to the turning process to predict the mean size of the droplets generated by atomization; and expressions for both the evaporation and settling behavior are established. Droplet size distribution and mass concentration predictions are used to characterize the fluid mist. Model predictions indicate that the droplet mean diameter is affected by both fluid properties and operating conditions, with cutting speed having the most significant affect. Model predictions and experimental results show that the number distribution of droplets within the control volume is dominated by small droplets because of the settling and evaporation phenomena. In Part 2 of the paper, the cutting fluid mist behavior model is validated using the results obtained from a series of experiments.