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Abstract: The development of a mathematical model for predicting rate of fire spread and intensity applicable to a wide range of wildland fuels is presented from the conceptual stage through evaluation and demonstration of results to hypothetical fuel models. The model was developed for and is now being used as a basis for appraising fire spread and intensity in the National Fire- Danger Rating System. The initial work was done using fuel arrays composed of uniform size particles. Three fuel sizes were tested over a wide range of bulk densities. These were 0.026-inch-square cut excelsior, 114-inch sticks, and 112-inch sticks. The problem of mixed fuel sizes was then resolved by weighting the various particle sizes that compose actual fuel arrays by either surface area or loading, depending upon the feature of the fire being predicted.

The model is complete in the sense that no prior knowledge of a fuel's burning characteristics is required. All that is necessary are inputs describing the physical and chemical makeup of the fuel and the environmental conditions in which it is expected to burn. Inputs include fuel loading, fuel depth, fuel particle surface-area-to-volume ratio, fuel particle heat content, fuel particle moisture and mineral content, and the moisture content at which extinction can be expected. Environmental inputs are mean wind velocity and slope of terrain. For heterogeneous mixtures, the fuel properties are entered for each particle size. The model as originally conceived was for dead fuels in a uniform stratum contiguous to the ground, such as litter or grass. It has been found to be useful, however, for fuels ranging from pine needle litter to heavy logging slash and for California brush fields. The concept of fuel models is introduced, wherein parameters of wildland fuels necessary for inputs to the model are categorized and tabulated. These are then used to predict fire spread and intensity; this eliminates the necessity for repeatedly measuring such parameters. The conceptual approach recognizes that fuels have inherent characteristics that are repeatable.