Room Fires
as a Design Determinant

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Potential fire intensity and fire spread are acknowledged to be important considerations in designing buildings. Most investigations in this area have attempted to relate fire intensity to fuel load. The author submits that room geometry may influence fire intensity and that architectural layouts around room openings may influence fire spread by means of convection.

It is felt that the ability to determine the potential intensity of fires and to predict the movement of fire in a building is essential in designing buildings. This paper will discuss factors influencing the maximum intensity of room fires and factors relating room fire intensity to the spread of fire to other rooms or spaces in a structure.

Occupancy Grouping by Fuel Load

In considering the relationship of building occupancy to fire intensity and fire spread, it seems logical to divide the occupancies into three groups. For sake of identification, the three groups are arbitrarily labeled light fuel load, moderate fuel load, and high fuel load. Those identified as light fuel load consist of situations of fuel and conditions related to the amount and rate of heat release from the fuel where the maximum available energy will not be sufficient to produce a fully developed fire, and the fire intensity will be less than that necessary to reach the point of flashover or otherwise involve the room in a full intensity fire.

Moderate fuel load occupancies are those where the fuel and the conditions determining the amount and rate of heat release from the fuel are such that a full intensity fire can develop, but where the total available fuel energy is less than that necessary to produce a level of fire severity capable of causing failure of structural elements or the passage of significant quantities of heat through fire resistive enclosures. Occupancies

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designated as high fuel load are those where the fuel and other determining parameters are such that it is possible to sustain an intense fire long enough to cause failure of structural members or fire stop barriers.

Numerous conditions of fuel, building geometry, and ventilation are determining factors in classification of an occupancy. The dividing line between light- and moderate-load occupancies is determined on the basis of intensity resulting from conditions within the room, and unless combustible interior finish or other surface flame spread conditions exist, is relatively independent of the basic structure. It would, therefore, be expected that a light fuel load situation would have the same fire characteristics in any type of construction from protected wood frame to fire resistive.

The dividing line between moderate fuel load occupancies and high fuel load occupancies would be determined by fire severity relative to the fire resistive capabilities of the structure. The upper end point of the moderate category would, therefore, vary according to the design of the structure. Because of the low fire resistance found in the ordinary dwelling, it would be expected that the moderate category would virtually disappear and conditions in a dwelling would be either light fuel load or high fuel load. In a building of fire resistive construction, however, the moderate category would be extended in size encompassing many types of occupancies — an important consideration for the designer.

This paper will concentrate on considerations relating to light and moderate fuel load occupancies, particularly the dividing point between the two and the effect on other occupancies in a structure when this dividing point is passed.

PAST STUDIES

It has been a general practice to consider the fire potential in a room on the basis of fuel load, and some attempts have been made to relate fuel load to intensity. There is a fair array of existing data, some of which appears to conflict.

Using flashover or radiant energy level as the determining point, a range of data can be found, such as flashover achieved in some of the work at the Research Institute of the Illinois Institute of Technology\textsuperscript{1} with fuel load concentrations as low as 1.85 pounds per square foot, the British work by Margaret Law\textsuperscript{2} in which she concludes that at 5 psf fuel load, the fire will run its course without developing full intensity; the Forest Products Laboratory test\textsuperscript{3} run in 1959 for the Insulation Board Institute where flashover was achieved at situations where the fuel load was slightly under 4 psf; and the recent tests run by the British Joint Fire Research Organization\textsuperscript{4} for British steel interests where flashover was achieved in a full size apartment setup at about 6 psf after a 47 min preburn. The Japanese have also run tests in this same area based on a cubic measurement in which they apparently achieved full intensity without the phenomenon of flashover.\textsuperscript{5} The Japanese data is not, however, convertible to