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## FIRE PROTECTION HISTORY-PART 270: 1918 (EXIT STAIR CAPACITY)

By Richard Schulte

The twenty-second Annual Meeting of National Fire Protection Association was held in Chicago in May 1918. Among the topics discussed at this meeting was the Report of Committee on Safety to Life. The following is a transcript of the portion of the Committee's Report addressing the determination of exit capacity, in particular, exit stair capacity:

"***METHODS OF ESTABLISHING ALLOWABLE NUMBER OF OCCUPANTS.***

***Stairs.***

***28.*** *Width of Stairs. One person shall be allowed for each unit measure of unobstructed stair width, which shall be not less than 16 inches in buildings erected prior to (date of enactment of rules), and not less than 20 inches in buildings erected after that date, provided, however, that a credit of 50 per cent of a full unit of stair width shall be allowed for an addition of 12 inches or more of clear stair width to one or more full units of stair width. The capacity of a stair is determined by its narrowest point, in so far as all persons above that point are concerned.*

*Note.–For example, a 28-inch stair in the case of an older building and a 32-inch one in the case of a newer building will rate as 1½ units of width.*

***29.*** *Pitch of Stairs. Stairs conforming to the foregoing sections shall be accepted as standard. Stairs having a pitch greater than 45 degrees shall have percentage allowance of standard, as follows:*

*Over 45 degrees and not exceeding 50 degrees . . . . 60%*
*Over 50 degrees and not exceeding 55 degrees . . . . 35%*
*Over 55 degrees and not exceeding 60 degrees . . . . 20%*

*No stair having an inclination with the horizontal of greater than 60 degrees will be permitted as a form of egress.*

***30.** Width of Treads. Stairs having a tread, exclusive of nosing, of less than 8 inches shall be penalized 20% for each inch or fraction thereof less than 8 inches, except that no stairs having a tread of less than 6 inches shall constitute a permitted form of egress, and provided, further, that where stairs are penalized for steepness of pitch no additional charge shall be made for narrowness of treads.*

***31.** Winders. For each winding stair tread, reduce allowed capacity 5% for all persons in the building above that point who use that stair, except that the maximum reduction shall not exceed 75%.*

***32.** The number of persons allowed on any floor above the first floor shall be based on the aggregate width of all inside and outside stairs leading from that floor to the ground, and shall be determined as follows:*

***Inside Stairs.***

*a. Establish the number of units and fractions of units of stair widths available on each stair, in accordance with rule 28.*

*b. Establish the number of stair treads from the floor under consideration to the next floor below, and allow one person for every two treads, and multiply by the number of units of stair width. Figure each stair separately where the number of treads varies. Deduct for stairs sub-standard as to pitch, width of treads, or winders.*

*c. Allow a credit of one person for each 4 square feet of floor and landing area enclosed in standard enclosures, provided that the aggregate credit for such enclosures does not exceed 100% of the aggregate capacity of the stairs as determined by a and b.*

*d. Reduce the capacity determined by a, b and c by one-third to allow for possible blocking of stairs by fire or smoke.*

*e. Where independent enclosed inside stairs are run from any floor to the ground in no way connected with any other floor, the persons on the floor so served may be 100% greater than established for a stair of similar size by a, b, and c.*

***Smokeproof Towers.***

*f. Proceed as in a, b, and c, but make no reductions as set forth in d. Where conditions are as set forth in e, make similar credit for smoke-proof towers as for inside stairs of this special type.*

***Outside Stairs.***

*g. Proceed as in a and b. For a stair having protection against fire within the building, allow one additional person for each 4 square feet of balcony area.*

*h. For all outside stairs make deduction as set forth in d.*

***Horizontal Exits.***

*I. The number of persons allowed in two or more sections or buildings connected by horizontal exit or exits conforming to the foregoing sections shall not be greater than can be accommodated in the adjoining buildings or sections on the basis of an allowance of 4 square feet of unobstructed floor space for each person, and in no case shall exceed a percentage increase of the actual capacity of the stairs in the connected sections or buildings, as follows:*

*Where a horizontal exit or exits connect sections or buildings occupied by the same tenant . . . . . 200%*

*Where a horizontal exit or exits connect buildings or sections occupied by different tenants . . . . . 100%*

***CONSTRUCTION, PROTECTION, AND OCCUPANCY.***

*j. The number of persons allowed on each floor of a building as established by the foregoing methods of calculation, shall on account of type of building construction, provision or lack of sprinkler protection, protection or lack of protection of vertical openings, story height of building, and character of materials stored or used, be multiplied by the percentages appearing in the tabulation herewith.*

*k. For each additional tenant in a building above two, deduct 5% of the total allowed capacity on all floors, except that maximum reduction shall not exceed 25%, and provided that the minimum number of persons per unit of stair width need not be less than the actual capacity of the stairs and stair enclosures as determined by a, b, c, and d above.*

*l. In a building in which more than one hazard classification occupancy is found, all those floors located above a higher hazard occupancy shall have their occupancies limited by the higher hazard.*

*m. Providing the total number of persons allowed in a building is not exceeded, it is permitted to increase the number of persons on one or more floors not to exceed 50% of the normal allowance on that floor or floors.*

### *EXPLANATION OF TABULATION OF PERCENTAGES.*

***33.*** *The tabulation submitted by the Committee in its report this year differs from the one of last year only in the following essentials:*

*a. The tabulation has been put in percentage form, the Committee having stated last year that such was its intent, although the tabulation did not so appear.*

*b. The better class of building construction has been extended to cover buildings of up to twelve stories in height.*

*c. Minor adjustments in allowances per floor have been made between the definitely established limits in order to make the changes more gradual.*

***34.*** *The manner in which this tabulation was established is as follows:*

*a. The fourth floor figures throughout were first established, because it was felt that a four-story building was the average height factory building.*

*b. It was assumed that the building with the stairs enclosed or protected was the standard.*

*c. For superior construction, credits of 10% for high hazard, 25% for moderate hazard, and 25% for low hazard were established. The percentages in the lower half of the chart are substantially these percentages higher than those in the upper.*

*d. For the provision of standard sprinkler equipment, credits were 50% for high hazard, 75% for moderate hazard, and 100% for low hazard occupancy. Approximately these differences will be found between the non-sprinklered and sprinklered percentage allowances in each half of the tabulation.*

*e. A 50% penalty, as against the standard condition of enclosed or protected stairs, has been provided for open stairs, and a 15% credit has been given where all other vertical openings have been protected. The relation of the three conditions of vertical opening protection in any one of the four divisions of the tabulation will be found to be substantially in accord with this decision.*

*f. For less hazardous occupancies it was desired to allow an increase of 50% for moderate as against high, and 100% for low as against high hazard. As a matter of fact, the tabulation works out with average credits of approximately 40% and 80% respectively.*

*g. The tabulation as originally drafted did not cover buildings higher than seven stories for either type of building construction, and the committee arbitrarily decided to make the maximum emptying time for the best buildings with the best protection conditions not more than 3 minutes, 4 minutes, and 5 minutes respectively for high, moderate, and low hazard occupancies. It was assumed that persons passing downstairs could travel at a rate whereby 45 would pass a given point in one minute, and a flat allowance was made of 30 seconds from the time alarm of fire was given until persons were in line at the points of exit. In this manner, then, were determined the total number of persons that might be allowed per unit of stair width distributed among all the floors from the second to the seventh inclusive.*

*h. The type of enclosed factory stair that will hold the largest number of people is that in which the stairs are superimposed and have a hallway running from the foot of one stair to the head of the next. An average capacity for stairs of this kind is about 15 persons per unit of stair width, and, making a deduction of one-third for possible blocking of stairs by fire or smoke, the figure 10 as the allowable number of persons per unit of stair width per floor was reached. The transformation of the original tabulation from one of figures to percentages, therefore, was a logical one and one which does not, in the opinion of the Committee, weaken the degree of control which it was intended to maintain of the number of occupants allowed in a building.*

*I. The number of persons allowed on the second story was next arbitrarily determined, and the number was much smaller than permitted on the basis of maximum emptying time established for the upper stories of buildings.*

*j. The allowances for buildings intermediate in height from two to seven stories were then established, smooth curves being through the second story, fourth story, and seventh story points which had been determined as described above.*

*k. The percentages for buildings of better construction from 7 to 12 stories in height were established by graphic means.*

*l. Special attention is called to the fact that the percentage appearing for a building of a given height applies to every floor in that building, and the rule is not that a different number of persons is allowed on different floors of the building, decreasing as the height of the story above the ground increases. The Committee has established a general rule permitting some overloading of individual floors if the total capacity of the building is not exceeded.*

*m. One of the most important features of the tabulation is the manner in which it is forbidden to use buildings of certain types for certain occupancies, and the manner in which the height of buildings which may be used for certain occupancies is definitely fixed. The need of securing increased life safety in buildings is particularly great in the more poorly built structures without sprinkler protection and containing high hazard occupancies. Application of the occupancy rules to good structures has indicated a generous treatment as regards number of occupants, which is justified by experience and by common sense.*

## *OCCUPANCY CLASSIFICATION.*

***35.*** *Last year your Committee submitted in preliminary form a very comprehensive list of occupancies classified according to three degrees of life hazard. The list of occupancies was that of the National Board of Fire Underwriters. Further consideration of the subject, with special reference to the question of enacting into law this important occupancy classification feature, has led your Committee to modify its attitude to the extent that the three classes of hazard are described and typical examples of practically an indisputable character are given under each heading. In connection with the enactment of a law or rule bearing on this subject, and the administration of the law or rule afterwards, the following unquestionably will be necessary:*

[**TABLE OMITTED**]

*a. The proper authorities should be empowered to establish a classification, to rule upon new occupancies as they arise, and to pass upon points under dispute.*

*b. Considerable latitude will be needed in the enforcement of such a law or rule, especially when there are occupancies of two or more degrees of hazard in the same building or section, and where the higher hazard ones do not predominate.*

*36. The Committee submits the following occupancy classification:*

***Low Hazard.***

*Occupancies involving the storage or use of materials which do not ordinarily burn rapidly or with excessive smoke, and from which neither poisonous fumes nor explosions are to be apprehended in the event of fire.*

*The following list indicates the types of occupancy coming within this class:*

*Asbestos.*
*Baking Powder.*
*Black lead.*
*Bottling.*
*Breweries.*
*Buttons (pearl or bone).*
*Canneries (for fish, fruit, and vegetables).*
*Chalk and crayon.*
*Condensed and powdered milk.*
*Electric light plants and power houses.*
*Electrolytic reducing works.*
*Glass.*
*Glue, mucilage, paste, and size.*
*Ivory.*
*Leather (excluding boots and shoes and japanning or enameling).*
*Metals (excluding japanning or enameling).*
*Porcelain and pottery.*
*Talc and soapstone.*
*Tanneries (excluding japanning or enameling).*

***Moderate Hazard.***

*Occupancies involving the storage or use of materials which are liable to burn with moderate rapidity and to give off considerable volume of smoke, but from which neither poisonous fumes nor explosions are to be apprehended in the event of fire.*

*The following list indicates the types of occupancy coming within this class.*

*Bags (cloth, burlap, and paper).*
*Bagging and burlap.*
*Bakeries.*
*Bamboo and rattan.*
*Baskets.*
*Belting (canvas).*
*Boots and shoes.*
*Buttons (metal or cloth covered).*
*Canvas.*
*Cardboard.*
*Carpets and rugs.*
*Clothing (woolen).*
*Cordage.*
*Furs.*
*Hair goods.*
*Horn and combs (not celluloid).*
*Leather (with enameling or japanning).*
*Linoleum works.*
*Metals (with enameling or japanning).*
*Packing houses.*
*Paper mills.*
*Printing, lithographing, bookbinding.*
*Silk.*
*Soap.*
*Sugar refineries (including beet and glucose works).*
*Tanneries (with japanning or enameling).*
*Textile mills.*
*Tobacco, cigars, cigarettes, and snuff.*
*Woodworking (excluding dipping or varnishing).*

***High Hazard.***

*Occupancies involving the storage or use of materials which are liable to burn with extreme rapidity or from which poisonous fumes or explosions are to be apprehended in the event of fire.*

*The following list indicates the types of occupancy coming within this class:*

*Artificial flowers.*
*Artificial leather.*
*Carpet linings.*
*Celluloid.*
*Cereal mills.*
*Chemicals of all kinds (except where serious flame, fume, or explosion hazards are not present).*
*Clothing (cotton).*
*Cotton batting.*
*Cotton waste.*
*Dry Cleaning.*
*Explosives.*
*Feather renovating.*
*Feed, flour, and grist mills.*
*Fireworks.*
*Imitation Leather.*
*Matches.*
*Rag sorting. (cotton).*
*Shoddy mills.*
*Starch mills.*
*Straw goods.*
*Varnish.*
*Woodworking (with dipping or varnishing).*"

This excerpt from the Report of the Committee on Safety to Life is of particular importance because it outlines the method to be utilized to compute the capacity of exits, in particular exit stairs. The methodology of determining exit capacity presented above considers enclosed stairs to be an area of refuge and computes the capacity of the stairs assuming that the stair enclosure will protect the occupants within the stair from the fire and other combustion products.

It should also be noted that the methodology presented above indicates that the egress time for buildings which are 7 stories or less in height should be between 3 and 5 minutes, depending upon the hazard of the building occupancy-3 minutes for high hazard occupancies, 4 minutes for moderate hazard occupancies and 5 minutes for low hazard occupancies.

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