V. DEVELOPMENT OF STANDARD

Basis for Previous Standards

The accepted consensus standard on the subject of emergency egress is the Life Safety Code, National Fire Protection Association Pamphlet No. 101. Its origin dates back to 1913 when the Committee on Safety to Life of the National Fire Protection Association (NFPA) was appointed as is stated on page 101-V. [27] During its early years, the committee devoted its attention to a study of historic fires involving loss of life and analysis of the causes of loss of life. This work led to the preparation of standards for the construction of stairways and fire escapes for fire drills in various occupancies, and for the construction and arrangement of exit facilities for factories, schools, and other buildings. These standards form the basis of the present Life Safety Code.

Early committee work resulted in the development of a series of pamphlets on egress and life safety, which were later consolidated into a comprehensive guide known as the Building Exits Code, first published in 1927. In 1942, the Coconut Grove Night Club fire in Boston focused public attention on the importance of adequate exits and related fire safety features. This interest was further stimulated by a series of hotel fires in 1946. The Building Exits Code was thereafter increasingly used for regulatory purposes. However, because the code contained many advisory provisions, the committee reedited the entire document, limiting the body of the text to requirements suitable for mandatory application.

In 1963, the Safety to Life Committee was reorganized and subsequently prepared the 1966 edition of the code. At that point, the title of the code was changed to the Code for Life Safety from Fire in Buildings and Structures.

As stated in section 1-2, paragraph 1-2111, of the Code, the purpose of the present Life Safety Code [27] is to specify measures which will provide that degree of public safety from fire which can be reasonably required. The code covers construction, protection, and occupancy features to minimize danger to life from fire, smoke, fumes, or panic before buildings are vacated. It specifies the number, size, and arrangement of exit facilities sufficient to permit prompt escape from buildings or structures in case of fire or other condition dangerous to life as is stated in section 1-3. [27]

The present Life Safety Code was designed to make it adoptable by municipalities to serve as a legal basis for requiring construction of buildings with concern for the life safety of the occupants. It is a comprehensive effort to develop a universal set of regulations. For that reason, and since many lack the capabilities to develop one of their own, or evaluate other municipalities' life safety regulations, many have adopted the code, or portions thereof.

The code outlines the general egress requirements for industrial occupancies. Although the major thrust of these requirements is directed toward egress from occupied buildings, it also outlines egress requirements for open industrial structures. Examples of such structures are those found in oil refining and chemical processing plants where equipment is in the open, and platforms, sometimes with roofs or canopies to provide shelter, but with no walls, are used for necessary access.

It is within this classification of open industrial structures that the emergency high egress hazard is greatest.

The American National Standards Institute (ANSI) has not developed a comprehensive consensus standard dealing with emergency egress from high workplaces. The chairman of the committees producing three ANSI standards which might have been expected to be concerned with worker egress from high places assessed the system by which ANSI develops safety standards. He stated that one weakness in the system is the absence of meaningful statistics to point out the need for standards in highly specialized areas such as worker egress from high places. (R Moore, written communication, November 1973)

However, some ANSI consensus standards have alluded to the problem of egress from high locations under emergency conditions. [28-30] Because the subject is treated in a cursory manner within the standards, the basis for the consideration of the subject has not been discernible.

The State of California Construction Safety Orders contain several standards dealing with the problem of emergency egress. [59,60] They require the use of an approved descent control device in combination with a lifeline and safety belt by employees using boatswains chairs and workers performing scaling and drilling operations on steep slopes. When adopting these requirements, California established a height of 15 feet or one story as the point above which workers must use the devices specified. The decision to specify 15 feet was arrived at through professional judgment on the part of those responsible for drafting the standard. (H Crabtree, oral communication, February 1974) Because the standard was ultimately adopted, it can be inferred there was no substantial public comment against this decision.

An auxiliary means of escape is required by the California Petroleum Safety Orders [61] covering drilling and production operations on derricks and masts. The hazards involved in these operations, when workmen are in the derrick above the wellhead, are blowouts and fires. The use of slide cables as an auxilliary device was effective in a number of instances. (G Bunker, written communication, January 1974)

The basic OSHA guideline on the subject of worker egress is Subpart E of the General Industry Standards. It is based on NFPA Life Safety Code No. 101. Subpart E established necessary features of building construction, arrangement, and equipment to facilitate safe egress in the event of fire or other emergency.

The subject of worker egress is treated in additional OSHA General Industry Standards. These include a requirement for an emergency electrical operating device on roof powered platforms which will permit lowering of workers stranded on platforms if the normal operation device should fail. Another provides for emergency operation of the main drive machine by manual cranking to permit lowering of the workers. Additionally, emergency communications equipment must be provided for each powered platform to provide communications between persons on the disabled platform and those operating the emergency lowering device. Another requirement, in 29 CFR 1910.261, Subpart R, is for at least one unobstructed exit on each floor at each end of a digester building.

In summary, worker egress from elevated workstations has been subordinated in importance by the standards-producing and standards-adopting agencies. The need for definitive standards on the subject has not been demonstrated by the amassing and analysis of relevant statistics. Specific language relating to the subject has, in some cases, been dropped during the standards-adopting process because of the technical nature of the requirements, their economic impact, or their potential for generating negative reaction on the part of factions within the labor/management arena.

When the subject has been included in consensus standards, it has been treated as an adjunct to the general concern of the standard, ie, to ensure that the worker is adequately protected against mechanical hazards.

Basis for Recommended Standard

The recommended standard is intended to provide all workers whose workstation requires their presence on an occasional, periodic, or daily basis, at a height of 15 feet or more above grade level, with a means of egress that considers three of the following hazard elements included in the Life Safety Code of the National Fire Protection Association [27] section 2-1, paragraph 2-113:

(1) Height of the workstation.

(2) Hazards associated with the occupancy of the work process.

(3) Number of persons exposed.

This recommended standard applies to all elevated workstations 15 feet or more above grade level except in high hazard situations. Lacking any definitive statistics or results of studies, professional judgment any definitive statistics or results of studies, professional judgment indicates that 15 feet above grade level be established as the lower limit for the standard proposed. In one instance, [62] this height was included in a safety standard concerned with worker occupancy of elevated workstations.

A study conducted for the city of Chicago [63] included the concept of recognizing the different evacuation and rescue procedures associated with emergencies in buildings having occupancies at varying heights. This concept is valuable in recognizing the egress needs of persons working at different levels and ensuring that the additional needs will be met.

Therefore, in the proposed standard, additional requirements are recommended for workstations above 80 feet in height. These are recommended because conventional firefighting ladder equipment cannot reach above 80 feet to provide a means of egress. [63] Furthermore, with high machinery and structures in industry, it is reasonable to assume that fewer means of egress are available as the height of the workstation increases.

Requirements for meeting more stringent medical qualifications have been included in the standard for those who work at heights of 80 feet or more above grade level, because they must rely more heavily on their physical, mental, and sensory attributes when using a means of egress from an elevated workstation under emergency conditions.

In their Life Safety Code, [27] section 4-2, paragraph 4-212, the NFPA recognized that different types of occupancies exhibit varying degrees of potential for fire. Similarly, the need for egress can be related to the hazards associated with the work process or type of facility and equipment. Therefore, the proposed standard includes, as has the Life

Safety Code, [27] paragraph 4-213, more extensive requirements for those workplaces where there may be a greater propensity for emergencies.

In consideration of the comparative speed of egress when using ramps, stairs, horizontal exits, and ladders, it seems reasonable to require the lowest ratio of workers to unit exits for ladders and the highest ratio to horizontal exits. Results from studies to validate the specific ratios selected are not available; these ratios were previously recommended by NFPA [27] and on review, professional judgment indicates that they are reasonable and should be required. The standard recommends provisions for dual egress from elevated workstations 15 or more feet above grade or floor level with a designed occupancy load of 10 or more workers. This is judged sufficient to permit a prompt evacuation of the site during emergency egress.

It is obvious that the need for egress facilities from elevated workstations is affected by the number of persons who must use those facilities in time of emergency. For standard egress facilities, therefore, the proposed standard requires evacuation capacity (expressed in units of exit width) based on the greatest number of people who would necessarily avail themselves of the means of egress during an emergency. The number of persons upon which the evacuation capacities are based were originally established by the NFPA and are the requirements of the Life Safety Code [27] as stated in section 5-1, paragraphs 5-115/5-116 and section 14-2, paragraph 14-213. A unit of exit width is defined as 22 inches as a sufficient representation for emergency egress purposes of the width of a worker. This unit is used by the NFPA in their code and is judged to be a reasonable value despite the fact that it will not be a comfortable width for some workers.

During the development of the proposed standard no data were found which indicated a definite quantitative relationship between the effects of the lack of emergency egress and the need for it. Therefore, a conservative approach has been taken to provide increased protection for workers who are exposed to the hazard associated with the need for emergency egress from elevated workstations.

VI. REFERENCES

1. 1970 Census of Population, Occupations by Industry. US Department of Commerce, Bureau of the Census

2. Ellis JN: Means of Egress for Overhead Workers. Wilmington, Del, Research & Training Corporation, September 1973 (unpublished report)

3. Illinois man falls to death from tower. Milwaukee Sentinel, August 24, 1973

4. Fall from bridge in Worth Twp. kills worker. Chicago Sun Times, September 20, 1973

5. Kiel FW: Hazards of military parachuting. Milit Med 130:512-21, 1965

6. De Haven H: Mechanical analysis of survival in falls from heights of fifty to one hundred and fifty feet. War Med 2:586-96, 1942

7. Rescue and Escape Systems From Tall Structures (RESTS). National Aeronautics and Space Administration, NASA-CR63-109:IV-58-70: 1963

8. Swearingen JJ, McFadden EB, Garner JD, Blethrow JG: Human voluntary tolerance to vertical impact. Aerosp Med 31:989-98,1960

9. California Work Injuries, 1968-1971. California Department of Industrial Relations, Division of Labor Statistics and Research, September 1969;September 1970; March 1972; December 1972

10. Falls to Different Level, State of Florida, 1967-1972. Florida Department of Commerce, Division of Labor, 1973

11. Compensated Cases Closed, New York State, 1969. New York Workmen's Compensation Board Research & Statistics Bull, pp 27, 28

12. Work Injuries in Pennsylvania, 1969. Commonwealth of Pennsylvania Department of Labor and Industry, pp 4, 14, 21

13. Descent Master Sales Brochure, Atlas Safety Equipment Co Inc, Brooklyn, NY

14. Sky Genie Sales Brochure, Descent Control Inc, Fort Smith, Ark

15. Auto Ace Sales Brochure, Uyeda Escape Chute Construction Company Ltd, Osaka, Japan

16. ERC Descent Governor Sales Brochure, Eastern Rotorcraft, Trans Technology Corp, Doylestown, Pa

17. Rescumatic Sales Brochure, Research and Trading Corp, Wilmington, Del

18. Automatic Descent Machine, in Quick Reference Book of Laws and Ordinances (Japan), 1972, Articles I, II, III, IV, V, VI

19. Inflatable Slides Sales Brochure, Air Cruisers Division, The Garret Corp, Belmar, NJ

20. Slide To Safety. Chicago Daily News, November 21, 1973

21. Offshore escape slides. National Safety News 108:18, 1973

22. Geronimo Escape Seat Sales Brochure, Taber's Welding Co, Perry, Okla

23. Super Ace Chute Sales Brochure, Uyeda Escape Chute Construction Co Ltd, Osaka, Japan

24. Heliports-Helistops in the United States, Canada, Puerto Rico. Washington, DC, Aerospace Industries Association, 1972

25. Copters rescue 400 from roof in Sao Paulo fire. New York Times, February 25, 1972

26. Committee on Rotorcraft External-Load Standards (B30.12): Proposed Definitions. Helicopter Association of America, 1973

27. National Fire Codes, Building Construction and Facilities: Code For Life Safety From Fire In Buildings and Structures NFPA, No. 101-1970. Boston, Mass, National Fire Protection Assoc, 1973, vol 4

28. Safety Requirements for Steel Erection, ANSI A10.13 1972. New York, American National Standards Institute Inc, 1972, section 10.1.5

29. Monorail Systems and Underhung Cranes, ANSI B30.11-1973. New York, American National Standards Institute Inc, 1973

30. Overhead and Gantry Cranes, ANSI B30.2.0-1967. New York, American National Standards Institute Inc, 1967, section 2-3.1.2

31. Manual of Procedures and Operation of Cranes Bull GW-30875. US Steel Corporation

32. Accident Control Manual for Overhead Travelling Cranes. British Steel Corporation, 1973, Item IV

33. Engineering for Safe Operation, booklet 8. American Oil Company, 1966, pp 46-47

34. Personnel lowering devices for airport traffic control tower cabs--Excerpts from order 1010.44, 2/29/68. US Department of Transportation, Federal Aviation Administration

35. Skilling GB: The case for evacuating high-rise buildings. Fire J 66:25-26, 1972

36. Sirkis JA, Mohler SR, Podolak E: Human factors of aircraft slide/raft combinations. Aerosp Med 45:553-58, 1974

37. Roebuck JA Jr, Levedahl BH: Aircraft ground emergency exit design considerations. Human Factors 3:174-209, 1961

38. Johnson DA: Passenger behavior in survivable aircraft accidents--Inaction under stress as a significiant behavior, in Human Factors in Aviation Safety. Western Psychological Association Symposium, Vancouver, BC, June 18-21, 1969

39. Hoffler GW, Turner HS, Wick RL Jr, Billings CE: Behavior of naive subjects during rapid decompression from 8,000 to 30,000 feet. Aerosp Med 45:117-22, 1974

40. Davis DR: Human errors and transport accidents. Ergonomics 2:24-33, 1958

41. Fleishman EA, Parker JF Jr: Factors in the retention and relearning of perceptual-motor skill. J Exp Psychol 64:215-26, 1962

42. Purdy BJ, Lockhart A: Retention and relearning of gross motor skills after long periods of no practice. Res 33:265-72, 1961

43. Ammons RB, Farr RG, Bloch E, Neumann E, Dey M, Marion R, Ammons CH: Long-term retention of perceptual-motor skills. J Exp Psychol 55:318-28, 1958

44. Berkun MM: Performance decrement under psychological stress. Human Factors 6:21-30, 1964

45. Johnson DA, Altman HB Jr: Effects of briefing card information on passenger behavior during aircraft evacuation demonstrations, in Proceedings on the 17th Annual Meeting of the Human Factors Society, Santa Monica, Cal, 1973, pp 215-21

46. Johnson DA: Effectiveness of video instructions on life jacket donning, in Proceedings of the 17th Annual Meeting of Human Factors Society, Santa Monica, Cal, 1973, pp 223-28

47. Individual flotation devices--TSO-C72a, in Technical Standard Order Authorizations, part 37, para 37.178. US Department of Transporation, Federal Aviation Administration

48. Special Study--Passenger Survival in Turbojet Ditchings. (A Critical Case), NTSB-AAS-72-2. US Department of Transportation, National Transportation Safety Board, 1972, 31 pp

49. Chisholm DM, Billings CE, Bason R: Behavior of naive subjects during decompression: For an evaluation of automatically presented passenger oxygen equipment. Aerosp Med 45:123-27, 1974

50. Davis RA, Moore CC: Methods of measuring retention. J Gen Psychol 12:144-55, 1935

51. Berkun MM, Bialek HM, Kern RP, Yagi K: Experimental Studies of psychological stress in man. Psychol Monogr Gen Appl Whole No. 534, 76:1-39, 1962

52. Sitterley TE, Pletan OD, Metaftin WE: Preliminary Investigation of Degradation of Firefighter Skills--Effectiveness of Training and Retraining Methods, D180-18113-1. Seattle, Washington, Boeing Aerospace Co, May 1974, 53 pp

53. Mengelkoch RF, Adams JA, Gainer CA: The forgetting of instrument flying skills. Human Factors 13:397-405, 1971

54. Hammerton M, Tickner AH: An investigation into the effects of stress upon skilled performance. Ergonomics 12:851-55, 1968

55. Pronko NH, Leith WR: Behavior under stress--A study of its disintegration. Psychol Rep 2:205-22, 1956

56. Poulton EC: Environment and Human Efficiency. Springfield, Ill, Charles C Thomas, 1970, chap 12,13,14,19

57. Goldstein IL: Training, in Margolis BL, Kroes WH (eds): The Human Side of Accident Prevention--Psychological Concepts and Principles Which Bear on Industrial Safety. Springfield, Ill, Charles C Thomas, 1975, pp 92-113

58. Windle CD, Ward JS, Nedved K, Nathan J: The Effect of Mock Tower Height in Airborne Training, Technical Report 29. Washington, DC, George Washington University, Human Resources Research Office, 1956

59. California Construction Safety Orders, California Administrative Code, Title 8, Art 7, Section 1548

60. California Construction Safety Orders, California Administrative Code, Title 8, Art 5, Section 1538

61. Petroleum Safety Orders--Drilling and Production, California Division of Industrial Safety, Title 8, Section 6573, 4

62. California Construction Safety Orders, California Administrative Code, Title 8, Section 1670

63. High Rise Building Fire Protection Study for The City of Chicago Ill, National Loss Control Service Corporation, 1971

VII. TABLE

NUMBER OF WORKERS HAVING POSSIBLE NEED FOR EMERGENCY MEANS OF EGRESS FROM HEIGHTS IN EXCESS OF 15 FEET*

Occupation	Number of Workers
Brickmasons and stonemasons	139,967
Carpenters	631,460
Carpenters' helpers	34,799
Cement and concrete finishers	60,856
Construction laborers	484,199
Cranemen, derrickmen, and hoistmen	74,958
Drillers, earth	14,648
Electricians	233,619
Heavy equipment mechanics	50,971
Mixing operatives	3,438
Oilers and greasers	5,121
Painters	209,551
Plumbers and pipefitters	243,293
Roofers and slaters	58,007
Structural metal craftsmen	2,966
Structural metal workers	49,175
Tile setters	23,943
Welders and flame cutters	63,438
Total	2,384,409

*Limited to the following SIC major groups:
Crude petroleum and natural gas extraction, construction, chemicals and allied products, petroleum refining, metal industries (includes blast furnaces, steel works, rolling and finishing mills, other primary iron and steel industries, primary aluminum industries, other primary nonferrous industries).

Taken from 1970 Census data [1]

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