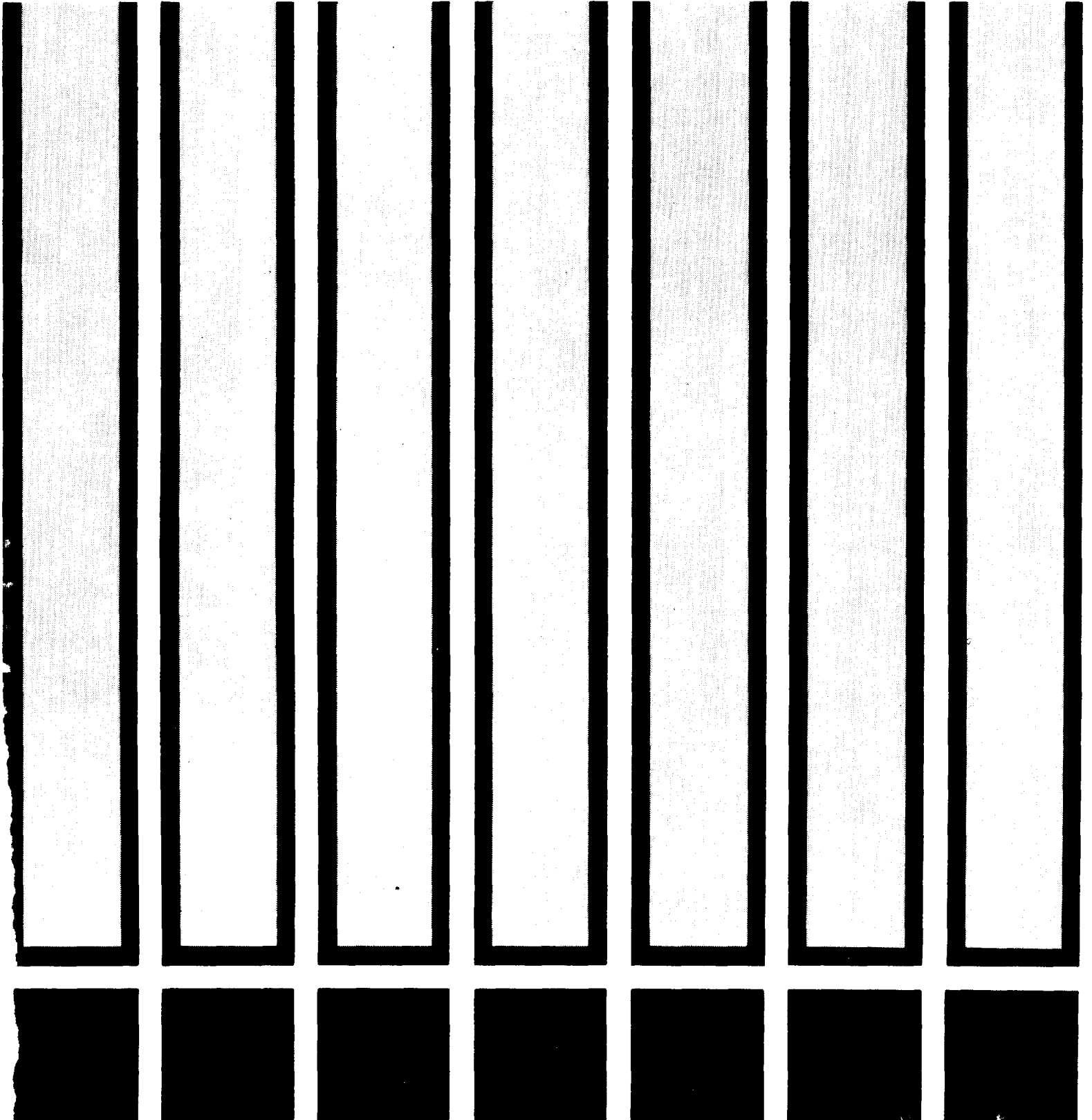


criteria for a recommended standard

EMERGENCY EGRESS FROM ELEVATED WORKSTATIONS



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**EMERGENCY EGRESS
FROM
ELEVATED WORKSTATIONS**



U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service

Center for Disease Control

National Institute for Occupational Safety and Health

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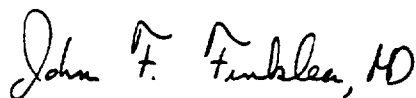
PREFACE

The Occupational Safety and Health Act of 1970 emphasizes the need for standards to protect the health and safety of workers exposed to an ever-increasing number of potential hazards at their workplace. The National Institute for Occupational Safety and Health has projected a formal system of research, with priorities determined on the basis of specified indices, to provide relevant data from which valid criteria for effective standards can be derived. Recommended standards for the control of occupational hazards, which are the result of this work, are based on the best available information. The Secretary of Labor will weigh these recommendations along with other considerations such as feasibility and means of implementation in developing regulatory standards.

It is intended to present successive reports as research and epidemiologic studies are completed. Criteria and standards will be reviewed periodically to ensure continuing protection of the worker.

I am pleased to acknowledge the contributions to this report on emergency egress from elevated workstations by members of my staff, the valuable constructive comments by the Review Consultants on Recommendations for Emergency Egress from Elevated Workstations, by the ad hoc committee of the American Society of Safety Engineers, and by Robert B. O'Connor, NIOSH Consultant in Occupational Medicine. The NIOSH recommendations for standards are not necessarily a consensus of all the consultants and professional societies that reviewed this criteria document on recommendations

for emergency egress from elevated workstations. Lists of the NIOSH Review Committee members and of the Review Consultants appear on the following pages.

A handwritten signature in black ink that reads "John F. Finklea, MD". The signature is written in a cursive style with a large initial 'J' and 'F'.

John F. Finklea, M.D.
Director, National Institute for
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The Office of Research and Standards Development, National Institute for Occupational Safety and Health, had primary responsibility for development of the criteria and recommended standard for emergency egress from elevated workstations. The National Loss Control Service Corporation developed the basic information for consideration by NIOSH staff and consultants under contract No. HSM-99-73-79. Robert H. Arndt, Ph.D., School for Workers, University of Wisconsin, developed most of the information for the training portion of the document. Maurice Georgevich had NIOSH program responsibility and served as criteria manager.

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CRITERIA DOCUMENT: RECOMMENDATIONS FOR A STANDARD FOR
EMERGENCY EGRESS FROM ELEVATED WORKSTATIONS

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I. RECOMMENDATIONS FOR A STANDARD FOR EMERGENCY

EGRESS FROM ELEVATED WORKSTATIONS

The National Institute for Occupational Safety and Health (NIOSH) recommends procedures and equipment for worker emergency egress from elevated workstations as set forth in the following sections. The standard is designed to assure workers of the availability of a means of emergency egress during situations in which there could be a threat to life, health, or safety.

Compliance with the standard should therefore prevent bodily injury or death resulting from: (1) unavailability or insufficient capacity of egress facilities; (2) unfamiliarity with emergency procedures and egress facilities; (3) inadequate identification and illumination of egress facilities; (4) lack of awareness of an imminent danger or present emergency; and (5) physical or medical conditions which adversely affect the worker's ability to make effective use of egress facilities.

Sufficient equipment and knowledge of its proper use exist to permit compliance with the recommended standard.

Section 1 - Definitions

(a) **Approved:** Listed or approved by the appropriate state or local government or by a nationally recognized testing laboratory such as Underwriters Laboratory.

(b) **Occupancy Load:** The total number of persons that may legally occupy a workstation at any one time.

(c) Unit of Exit Width: Each 22-inch wide segment of a standard means of exit. For purposes of this standard, fixed, portable, or job-made ladders of standard construction shall constitute one unit of exit width. Requirements for standard means of egress are expressed in units of exit width and are determined according to occupancy load.

(d) Workstation: Any place to which an employee is assigned either on a regular, temporary, or occasional basis for the purpose of completing an assigned task.

(e) Open Structures: Buildings under construction and operations conducted in the open air such as those often found in oil refining and chemical processing plants where platforms, sometimes having roofs or canopies but no walls, are used for access to outdoor elevated equipment.

Section 2 - Means of Egress

(a) For purposes of this standard, means of egress is defined as a method of access to a separate area that is safe or leads to a safe place.

(b) Means of egress shall be classified as standard or special.

(1) Standard means of egress:

(A) Stairways

(B) Fixed industrial stairs meeting the requirements of 29 Code of Federal Regulations (CFR) 1910.24 or 1926.501.

(C) Ramps meeting the requirements of 29 CFR 1910.23 or 1926.500.

(D) Horizontal exits, such as doorways and walkways.

(E) Fixed ladders meeting the requirements of 29 CFR 1910.27 or 1926.450.

(F) Portable ladders meeting the requirements of 29 CFR 1910.25, 1910.26, or 1926.450.

(G) Job-made ladders meeting the requirements of 29 CFR 1910.25 or 1926.450(b).

(2) Special means of egress:

(A) Approved controlled descent devices, slides, and chutes.

(B) Vehicle-mounted elevated and rotating work platforms meeting the requirements of 29 CFR 1910.67.

(C) Scaffold stair towers meeting the requirements of 29 CFR 1910.29(c).

(D) Personnel hoists meeting the requirements of 29 CFR 1926.552. Such personnel hoists shall have an immediately available auxiliary source of operating power in the event the normal electrical power is interrupted.

Section 3 - Environment

(a) Height of Workstation

(1) These requirements apply to all workstations occupied by one or more employees for purposes of working at heights of 15 feet or more above floor or grade level, or at any elevated workstation where normal egress may be impeded by the consequences of a highly hazardous situation. (Examples of elevated workstations are maintenance platforms, elevated storage tanks, and crane cabs. Examples of highly hazardous situations are the presence or use of flammable, highly reactive, or toxic chemicals.)

(2) Additional requirements apply when the workstation is 80 feet or more above floor or grade level. (Examples include structural steel erection, television tower construction and maintenance, bridge painting, and water tower construction and maintenance.)

(b) Workplace Hazard Classifications

(1) Low Hazard Situation: Situations where there is not a reasonable probability that danger to life, health, or safety may suddenly develop.

(2) High Hazard Situation: Situations where there is a reasonable probability that danger to life, health, or safety may suddenly develop.

(c) General Requirements

(1) Every workstation or open structure 15 feet or more above the permanent or temporary floor or ground level, in a low hazard situation that is designed for an occupancy load of 10 employees or more, shall be provided with at least two means of egress. (Examples of such workstations include maintenance platforms and elevated storage tanks.)

(2) Every elevated workstation above the permanent or temporary floor or ground level, in a high hazard workplace where egress may be impeded by obstructions, shall be provided with at least two means of egress without regard to the minimum number of employees occupying the workstation.

(3) Egress facilities must be available and useable at all times in buildings under construction. Such egress facilities shall consist of doorways, walkways, and items listed in Section 2 - Means of Egress. The capacity of the combined means of egress shall be sufficient

for the occupancy load, but in no instance shall there be less than 2 means of egress remote from one another.

(4) The capacity of a unit of exit width shall be as follows:

(A) Standard egress facilities (as listed in Section 2 - Means of Egress, paragraph b, items 1, A-G).

(i) Stairways--One unit for each 60 persons.

(ii) Ramps--One unit for each 60 persons.

(iii) Horizontal exits--One unit for each 100 persons.

(iv) Ladders (standard fixed, job-made, or portable)--One unit for each 15 persons (Note--A standard fixed, job-made, or portable ladder conforming to applicable standards will be considered as one unit of exit width.)

(B) Special egress facilities (as listed in Section 2 - Means of Egress, paragraph b, items 2, A-D). Special devices shall be installed by the employer only after evaluation of the workplace egress needs, with due consideration to the capacity limitations of such devices.

(5) Emergency egress facilities shall be positioned as far from each other as practicable provided that they are so arranged that travel of more than 100 feet from any point to the nearest means of emergency egress will not be necessary, except in high hazard situations where travel distances shall not exceed 75 feet.

(6) On every workstation of such size, arrangement, or occupancy that a fire or other emergency may not in itself provide adequate warning to the workers who may be occupying the workstation, emergency

alarm facilities shall be provided as necessary to warn workers of the existence of fire or other emergency so that they may escape, or to facilitate the orderly conduct of egress drills. Where employees are required to work alone and away from direct contact with supervisory personnel or other employees, a reliable means of warning shall be provided, eg, two-way radios, telephones, "intercoms," or alarms.

Section 4 - Medical

(a) All employees shall have made available to them preplacement medical examinations. These examinations shall include medical and occupational histories.

(b) For those employees working at heights of 15 ft or more, but less than 80 ft, these examinations shall include observations of depth perception, fields of vision, reaction time, manual dexterity, coordination, and any abnormal tendencies toward dizziness.

(c) Preplacement examinations for employees working at elevated workstations of 80 ft or more above grade shall also include:

(1) Tests of visual acuity to ensure at least 20/30 Snellen (or equivalent) in one eye, and 20/50 in the other, if necessary with corrective lenses. Tests of color perception to ensure ability to distinguish those hazards or warning signals applicable to the job.

(2) Tests of hearing, with or without hearing aids, to ensure at least 15/20 for ordinary conversation in one ear, or alternatively, a hearing loss of not more than 20 db in the normally tested frequencies.

(3) Observations of strength, endurance, agility, coordination, and speed of reaction sufficient to meet the demands of the work or operation, as applicable.

(4) Evidence of other defects, such as cardiovascular disease, epilepsy, diabetes, or emotional instability which could render the employee a hazard to himself or others in an emergency situation.

(d) The medical requirements of this recommended standard do not apply to employees working in buildings under construction where the workstation is enclosed by the exterior building walls and where the permanent floors have been installed, even though the workstations may be at or above the 15-foot outside grade level.

(e) These examinations shall be reviewed yearly and repeated at a frequency determined by the responsible physician in order to provide the worker with current evidence of physical ability to perform the job safely and meet the requirements of egress.

(f) The employer shall ensure that pertinent medical records are maintained and are available for review during the term of employment. These records shall be available to the medical representatives of the Secretary of Health, Education, and Welfare, of the Secretary of Labor, of the employee, and of the employer.

Section 5 - Posting

(a) Instructions for proper use of any special devices used for emergency egress shall be prominently posted in all workstations subject to this standard.

(b) Instructions for evacuation procedures established by the employer shall be posted in places readily accessible to employees, in each work area subject to this standard.

(c) Instructions shall be printed in English. They shall also be printed in the predominant language of non-English-speaking workers, if any, unless these workers are otherwise informed. All illiterate workers also shall be so informed.

(d) Each path of escape from the work area to a place of safety shall be so arranged or marked that the route is unmistakable. Arrows pointing to exit routes or "Exit" signs may be used for this purpose.

(e) The minimum level of illumination along the entire path of egress shall be not less than 5 foot-candles (preferably 10-15 foot-candles) with provision to maintain this level in the event of power failure.

Section 6 - Appraisal of Employees of Hazards Associated with Elevated Workstations

All employees who work at an elevated workstation as defined in this standard shall be instructed and kept informed by their employer with respect to their duties in the event of emergency situations. Their attention shall be directed to placards (see Section 5 - Posting) and they shall be properly trained in means of escape (see Section 7 - Work Practices).

Section 7 - Work Practices

(a) Emergency procedures shall be developed by the employer and made available in written form to the immediate supervisor for implementation. This plan shall include the company policy statement regarding emergency plans, a description of warning and communications procedures, diagrams showing emergency egress routes, and a list of available emergency equipment. This plan of emergency procedures shall be reviewed and, if appropriate, updated when changing conditions within the workplace limit the effectiveness of the plan, but in no case less than annually.

(b) All employees who work in locations covered by this standard shall be trained according to the following rules:

(1) All employees who work on a regular, temporary, or occasional basis shall be trained in the use of required means of emergency egress. Training shall not be considered complete until the supervisor or other employer-designated official (eg, safety or training officer) judges that an acceptable degree of proficiency in the use of the means of egress from the high workstation has been attained. The trainee's judgment of the adequacy of his training should be properly considered.

(2) Initial training shall be conducted prior to assignment to the workstation. This training shall include:

(A) Appraisal of the type and severity of recognized hazards which may produce emergency situations.

(B) An explanation of the means of detecting the presence of an emergency, including alarm systems.

(C) Training in the use of any other protective equipment, such as respirators, which may be required during egress.

(3) Each individual covered by this standard shall participate in training drills designed to maintain proficiency at intervals no longer than three months or at another interval determined by the judgment of a professional safety engineer.

(4) All training shall be designed and conducted in such a way as not to create an unnecessary hazard. Where the nature of egress might create a falling hazard, training shall be conducted with the same means of egress but at heights lower than 10 feet or with a lifeline attached to the employee.

(5) Where feasible, initial training shall include use of the special egress procedures and equipment. Periodic training shall also include use of such procedures and equipment.

Section 8 - Preventive Maintenance, Inspection, and Recordkeeping Requirements

(a) All egress facilities shall be inspected and maintained as often as is necessary to ensure that they are clearly accessible and in proper operating condition. Such inspections shall consider weather, exposure to corrosive atmospheres, and other adverse conditions which could affect the operation of the equipment.

(b) All alarm and communication systems and components shall be tested as often as is necessary to ensure that they are in reliable operating condition.

(c) The employer shall maintain a written record of all training including drills, inspections, tests, and maintenance required. The records shall be retained for a period of three years from the date of training, inspection, test, or maintenance. These records shall be available to the authorized representatives of the Secretary of Labor and of the Secretary of Health, Education, and Welfare.

II. INTRODUCTION

This report presents the criteria and the recommended standard to meet the need for safety procedures and equipment for emergency egress from elevated workstations. The criteria document fulfills the responsibility of the Secretary of Health, Education, and Welfare, under Section 21(c)(1) of the Occupational Safety and Health Act of 1970 to "...develop and establish recommended occupational safety and health standards."

The National Institute for Occupational Safety and Health (NIOSH), after a review of data and consultation with others, developed criteria upon which standards can be established to protect the safety of workers from exposure to hazards. The recommended criteria for a standard should enable management and labor to develop better engineering controls resulting in safer work practices, but they should not be used as a final goal.

These criteria for a standard are a part of a continuing series of criteria developed by NIOSH. The proposed standard applies only to emergency egress from elevated workstations as applicable under the Occupational Safety and Health Act of 1970.

The criteria are based on a comprehensive survey and evaluation of current regulations from the following:

- (1) Occupational Safety and Health Administration.
- (2) American National Standards Institute.
- (3) National Fire Protection Association.
- (4) Federal Aviation Administration.
- (5) California Safety Orders.

(6) Japan Fire Regulations.

Additionally, a literature search was conducted in order to review the technology pertaining to human escape from elevated areas, including those involving industrial areas and buildings under construction.

III. EFFECTS OF EXPOSURE

Extent of Exposure

An emergency egress situation is one in which the usual means of egress, for one or more workers, has been blocked or eliminated, and there is a need for prompt escape, because of a work accident, fire or explosion, power shutdown or other disaster. As will be developed later in this document, egress is normally a problem at elevations of over 15 feet.

From data taken from the 1970 census of the United States, it is estimated that approximately 2.4 million workers could be working, on an occasional or regular basis, at a height of over 15 feet or more above the grade or floor level. The census data are summarized in Table VII. [1]

While the number of individuals who work at elevated workstations is important in determining the extent of exposure, it is also important to determine the frequency of occurrence of high egress emergency situations. Statistical data to identify such occurrences are not reliable because many high egress emergency situations have been described as "falls" or "burns." For example, a crane operator burned in his cab due to lack of egress has a "burn" injury, while one who jumps has a "fall." [2] Newspaper articles often relate events concerned with workers falling from heights [3,4]; however, they fail to give details covering the emergency situation which the workmen faced.

Historical Reports

In 1783 Sebastian Lenormand made a descent from the top of an observatory in France. Using an umbrella-like device, he landed safely and

regarded the apparatus as a new means of escaping from fires in tall buildings. [5] De Haven [6] in 1942 reported eight cases where adult men and women survived after jumping or falling from heights of between 55 and 146 feet. Although this report examined bodily injuries due to falls, ie, the mechanical and physical laws interacting between the human body and the impact medium, its importance relates primarily to efforts to reduce injury resulting from impact and not to providing alternate means of egress from an elevated workstation.

Since World War II, US Army parachute training injuries at Fort Benning, Georgia, have been closely followed. [5] The injury rate has been consistently below 1%. However, the data are of little applicability, because practice jumps from heights offering any potential for significant injury are made with harness-suspension and descent devices. Thus, the use of these built-in safety measures are not representative of the type of emergency situation faced by workers where an alternate means of egress from an elevated workstation is required.

Effects on Humans

Very little research, if any, has been conducted in the area of the psychological stress on humans during the need for emergency egress from high workstations, according to a written communication from M Wilson, American Psychological Association, December 1973.

A "threat-to-life" psychological stress test situation was described, however, in the final report of a research project conducted for the National Aeronautics and Space Administration by the Martin Marietta Corporation. [7] The results of the tests indicate that persons under

stress could experience a loss of operational efficiency of up to 34 %. Additional statistics cited in the report show that under emergency situations, 10 times as many men as normal may be required to operate equipment with which the men are familiar. Analysis of these data indicated that psychological stress during emergencies may lower operating efficiency within a group by as much as 90%.

This report concluded that, as a result of the breakdown of reasoning and decision-making processes during emergencies, the following items should be made an essential part of egress systems:

(1) A minimum of decision-making should be required on the part of the user.

(2) The egress procedure should be as simple as possible.

(3) The egress procedure sequence should be as close as possible to commonly used procedures.

Three recommendations in the report [7] also are of prime interest in the development of egress systems.

(1) The system should be reliable, safe, and fast.

(2) The system should be simple to operate.

(3) The personnel who will use the system should have extensive training in its use.

There is also a lack of published data documenting the physical effects on the human body of jumping or falling from high machinery or structures in industry. (Written communications from A Harrison, National Technical Information Service, US Department of Commerce, and from IJ Bhambri, Smithsonian Science Information Exchange Inc, 1973)

Swearingen et al [8] tested the maximum gravitational force (G-force) the human body could tolerate while in various positions when subjected to vertical impact. A total of 500 test drops were made with 13 volunteers in a specially constructed drop mechanism. G-force tolerance was determined by progressively increasing the impact loadings to the point where subjects complained of severe pain.

Some of the test drops were conducted with the volunteers in a standing position with knees bent slightly, allowing the trunk, head, and arms to sustain less severe impacts. This is the position that would be assumed in reaching grade level after jumping from height during an emergency. However, because the construction of the test mechanism limited the height from which test drops could be made, it was impossible to determine maximum G-force impact tolerances with the body in this position.

Because the study concerned only G-force tolerance, it failed to include sufficient data to extrapolate the heights from which the drops were made. Moreover, those tests which did establish maximum G-force tolerances were conducted with the body seated in a rigid chair, seated in a chair containing shock-absorbing material, standing with knees locked, or squatting with knees fully flexed. These positions could not realistically be expected in case of voluntary jumping from heights.

Of significance, however, is the fact that this study demonstrates a feasible method of determining the heights from which a person could jump without injury.

Injury data from the states of California, [9] Florida, [10] New York, [11] and Pennsylvania, [12] although reflecting reliable recordkeeping, are inadequately classified to allow identifying the number

of injuries from emergency egress. For example, California includes in "falls or slips from elevation," [9] falls by workers from loading docks, slightly elevated platforms, vehicles, down steps, etc.

Florida includes in its accident data "falls to a different level" covering 1967 through 1972. [10] Included are scaffold falls, falls from walkways and platforms, falls into excavations, shafts, floor openings, and falls from roofs and wall openings. There is no information relating these injuries to the lack of emergency egress facilities.

As with California and Florida, data from New York and Pennsylvania reflect the same concerns--accidental falls, presumably including, but not limited to, egress situations in high structures and machinery. [11,12] Insurance industry statistics have not been made available for this review. However, it is understood that these data include incomplete information with respect to emergency egress facilities. For example, falls from elevations include falling in holes, off platforms, through wall openings, etc, without further identification of causes.