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Human Behavior and Fire Emergencies: An Annotated Bibliography

December 1981

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**U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards
Center for Fire Research
Washington, DC 20234**

and

**U.S. Department of Health
and Human Services
Washington, DC 20201**

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**HUMAN BEHAVIOR AND FIRE
EMERGENCIES: AN ANNOTATED
BIBLIOGRAPHY**

R. L. Paulsen

December 1981

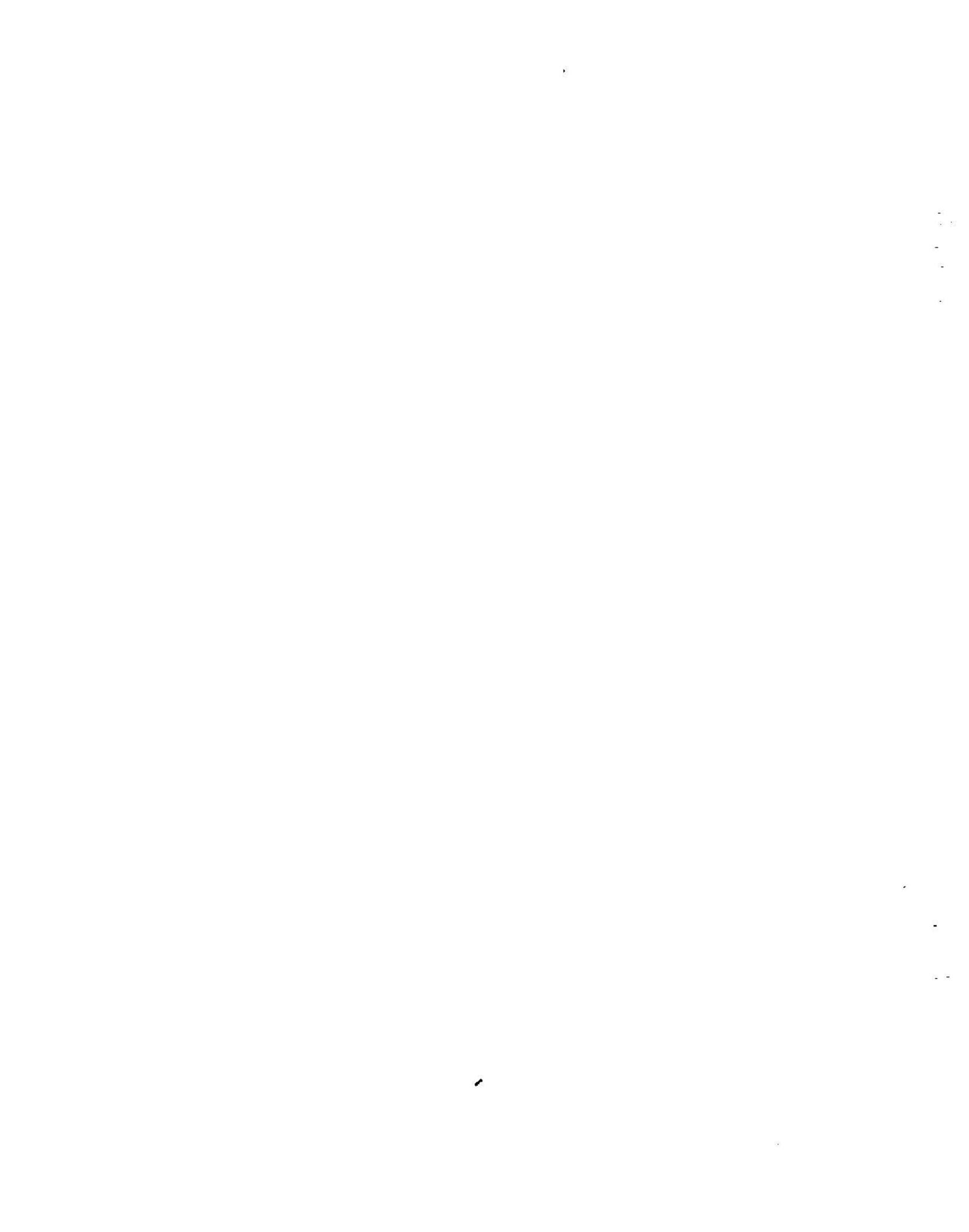
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U.S. DEPARTMENT OF COMMERCE, Malcolm Baldrige, *Secretary*
NATIONAL BUREAU OF STANDARDS, Ernest Ambler, *Director*



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PREFACE

This report is a product of a joint effort of the Department of Health and Human Services (HHS) and the National Bureau of Standards (NBS) Center for Fire Research. The program is a continuing activity initiated in 1975. It consists of projects in the areas of: decision analysis, fire and smoke detection, smoke movement and control, automatic extinguishment, and behavior of institutional and other populations in fire situations. Many of the National Bureau of Standards' reports referenced in this bibliography were also produced as a part of this joint effort with the Department of Health and Human Services.

This bibliography contains an extensive, though by no means exhaustive, annotated listing of references pertaining to human behavior and fires. The scope is broad: the references cover the full range of behavioral responses through the different stages of a fire emergency in the context of a variety of occupancy settings. Many research approaches are represented, e.g., case studies of individual incidents, survey studies of large numbers of incidents, theoretical analyses and representations of the fire situation, computer models, literature surveys, and psychological studies of selected populations.

Many of the references in this annotated bibliography are also contained in the report, NBS GCR 78-138, "Human Behavior in Fire - a Bibliography," entry number 16 in this bibliography. My appreciation is extended to Dr. John Bryan of the University of Maryland for this valuable source of references.

Although not a publication and therefore not listed in this bibliography, I would like to call to the reader's attention another important product of the joint HHS/NBS effort in the field of fire and life safety--the film "Flashover: Point of No Return." This 12-minute training film explains the important concept of flashover and illustrates appropriate behaviors for staff in health care institutions during fire emergencies. Information on obtaining this presentation is contained in the "Ordering Information" section of this report.

The reader should also be aware that Mr. Jake Pauls of the National Research Council of Canada is currently preparing an extensive review of the literature on evacuation. It may be distributed formally as a Building Research Note of the Division of Building Research/National Research Council of Canada, Ottawa, Canada K1A 0R6. This review is scheduled to be ready for the November 1981 International Life Safety and Egress Seminar which Dr. John Bryan is hosting at the University of Maryland.

A comprehensive, up-to-date bibliography is an important aid to other researchers, particularly in a new and developing field such as human behavior and fires. Knowledge of behavior in response to fires can be of assistance in the development of effective fire safety emergency plans and training programs, and in the choice of appropriate facility design and fire safety hardware.

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Abstract

This report contains an annotated listing of 161 selected references pertaining to human behavior and fire emergencies. The scope is broad: the references cover the full range of behavioral responses through the different stages of a fire emergency in the context of a variety of occupancy settings. Health care institutions are the most frequently represented occupancy type. Many research approaches are included; e.g., case studies of individual incidents, survey studies of large numbers of incidents, theoretical analyses and representations of the fire situation, computer models, literature surveys, and psychological studies of selected populations. The work of researchers from many nations, including the United States, Canada, Great Britain, Japan, West Germany, France, Belgium, and the U.S.S.R., is referenced. Annotations for papers from the first two international conferences on human behavior in fires (March 1977 and October 1978) are contained in this bibliography. There is a topical index to provide the reader with a preliminary guide to those references regarding a particular occupancy type, research approach, design feature, or category of behavioral response. An introductory essay provides an overview of the field of human behavior and fires and develops some common themes found in the literature.

HUMAN BEHAVIOR AND FIRES:

AN INTRODUCTION

The study of human response and capabilities in fire emergencies is an essential part of a total, systematic, assault on the problem of fire fatalities and losses in all types of occupancies. On the negative side, there is the human factor in ignition of unwanted fire, whether through intent or carelessness,¹ and the role of people in exacerbating a situation through generally inappropriate actions, or actions which undermine the effectiveness of the installed fire safety systems. From a positive viewpoint, human capabilities can be utilized, to a degree, to enhance installed fire safety systems or compensate for shortcomings in such systems.

The study of human behavior and fires is still in its infancy, although in the 1970's, beginning with the Wood study completed in 1972, there was an intensification of interest and effort, with some major, systematic studies and numerous smaller ones subsequently being carried out. This area of scientific study is beset by methodological problems-- experimental subjects obviously cannot be placed in real fire situations,² after-the-fact testimony from participants in fires may contain errors,³ and where samples are limited or not representative, conclusions must be

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Improper use of cigarettes and alcohol, and the prevalence of arson are particularly significant. See references: 8, 78, and those listed in the index under "firesetters."

2

A reference of interest here is 108; also see references listed in the index under "experimental studies."

3

A reference of interest here is 119.

drawn cautiously. Nevertheless, there is considerable consensus among researchers concerning certain recurrent themes which have emerged from these studies. The central perspective on human behavior in fires which researchers have developed can be stated as follows: Despite the highly stressful environment, people generally respond to emergencies in a "rational," often altruistic manner, in so far as is possible within the constraints imposed on their knowledge, perceptions, and actions by the effects of the fire. In short, "instinctive," "panic" type reactions are not the norm. The historic emphasis in the press and regulatory literature on the likelihood of "instinctive" or "panic" reactions is inaccurate and counterproductive. The serious researcher might cringe at such dramatic headlines in the popular press as "Panic Kills 300" or "...when confronted by a blaze, most people behave pretty foolishly..." Such attention-getters are either erroneous or, at best, oversimplifications.

Approaches

Researchers have turned their attention to the whole range of behaviors exhibited by persons in fires, from their first awareness of a possible problem through completion of the evacuation process. The bulk of the data has been obtained through studies of actual fire

¹
For examples, see reference 125, pp. 64-71.

²
a British newspaper headline regarding the Beverly Hills Supper Club fire, from reference 125

³
from Parade, the Sunday Newspaper Magazine, February 10, 1980

incidents. In-depth case studies of individual incidents have been conducted as well as statistical, summary studies of large numbers of incidents. There has been a progression from largely descriptive studies-- what was done, how often, by whom, in what order--to more complex analytical studies which attempt to extract typical behavior patterns or relate both behavior and fire development in a time sequence.¹ Relating behavioral actions to a time frame is particularly important, since the appropriateness of an act such as "fighting the fire" is critically related to the stage of fire development at which it occurs. (38, p.132; 148, p.90) The whole behavioral process is taking place as the fire itself may be rapidly developing, and "what is an appropriate action at one stage may be quite inappropriate a minute later." (109, p.37)

A further direction which research can take (with implications for training and education), suggested by such researchers as Wood, Keating, and Bryan, is the exploration of the reasoning and motivation behind a participant's choice from among the alternative actions available to him. Why did he choose to perform a given act first, and how did the outcome of his actions match his expectations?

Much attention has been directed toward identifying sequences of actions followed by those involved in fires. Unfortunately, it is not as simple to prescribe the appropriate sequence of actions to follow in a fire emergency, as it is to specify a step-by-step procedure as, for example, in the assemblage of a piece of electronic equipment.

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For a description of the latter technique, see Lerup references 85 and 88. Bryan has used this technique in an extensive series of case studies of health care facility fires. In particular, see reference 27.

Larup states the point strongly: "There are at present no official strategies for life safety that can stipulate a correct sequence of actions to follow...the physical environment cannot be designed to literally reflect a specified sequence of actions...no two fires are alike..." (86, pp.155, 156) Canter similarly makes this point. (36, p.5) Bickman, in his study of the effectiveness of training of nursing home staff on knowledge of appropriate behavior in fire, (70) encountered the difficulty with sequence of actions when quizzing staff on the selection of first and second actions to be performed in case of emergency. The plan of the nursing home under study contained contradictory instructions--at one point staff were instructed to remove residents from the fire area and then pull the alarm, while further down the same page exactly opposite instructions were written. Bickman concludes that the decision of which action to perform first might be regarded as being "situationally-bound," that is, dependent on the severity of the fire, number of patients in immediate danger, distance to a pull alarm box, and so forth.

There are, nonetheless, some simple, critically important directives which are generally applicable to fire emergencies: for example, response to alarms should be immediate and appropriate (without time being wasted seeking verification of the existence of a fire); the occupant should not attempt to fight any but very small, contained fires; the door to the room of fire origin should be closed immediately after all persons have left; and rooms (or buildings) should not be reentered during the course of a fire to retrieve possessions. In the case of a health care institution, frequently more than one staff member is close by, so that while one staff member is evacuating the immediately endangered patient another can be pulling the alarm, closing other doors, etc. In many instances, automatic detection devices will have sounded the alarm.

People and Design

Exit systems

This bibliography contains numerous descriptions and analyses of the evacuation process. The initial physical science "carrying capacity" approach to egress assumes that occupants respond immediately to an emergency (like water or gas particles) and are affected only by spatial configuration and density during the actual evacuation process. The "human response" school of research also considers the influence on evacuation time of such human factors as decision-making in an ambiguous situation or organizational factors such as the presence of trained supervisors or communications systems. (133) Stahl's computer simulations of egress behavior in building fires are notable for their incorporation of human interaction and decision-making variables. (127-129)

Behavioral research has shown that it is erroneous to assume that behavior in fires is a simple process largely controlled by exit and alarm systems. (109) From his observations of large scale evacuations of high-rise office buildings, Pauls concluded that an exit that is not normally used will carry significantly fewer people in an evacuation. Codes currently credit exit capacity to stairs regardless of their normal use. Pauls' work is perhaps best known for exposing problems in the traditional 22-inch unit-exit-width basis for exit rules. (106) He asserts that "even in simple, total evacuation drills, evacuation times have been observed to be as much as twice as long as had previously been predicted" and "Given...improved awareness of the complexity of behavior in fires, we should think of evacuation time predictions-even those based on realistic conservative flow assumptions-as minimums and not maximums, as is sometimes argued." (109,p.39)

In one nursing home fire, perimeter stairs not normally used by residents were not used by staff to evacuate residents in a fire emergency, even though their use in the emergency would have been most appropriate. Rather, a center stairway was used, although it meant that most residents were moving toward the fire. A security alarm had been set off often in the past by residents who had attempted to leave through the perimeter exits, and some residents who were caught using these exits had been scolded. (51)

One possible explanation for the tendency to use habitual routes during emergency evacuations may be found in the psychological research on fear and stress: "...under heightened anxiety, people's attention becomes narrowly focused; they are aware of only the most obvious aspects of their environment. Peripheral cues, which are usually easily processed, remain unobserved." (79a, p. 19)

Alarms

The question of the effectiveness of alarms is dealt with frequently in this bibliography, either directly and exclusively as in accounts of experimental studies or as a part of fire incident case studies. Whether or not an alarm will awaken a person is dependent on more than just the noise level of the alarm or its noise level in relation to ambient noises. Sounds that have "meaning" for the sleeping person are more likely to awaken him. Not only do individuals differ from one another as to the noise level necessary for awakening, but a given individual will require different levels at different times depending upon such conditions as sleep stage, time of night, or medication. (10, 103, 111)

The frequency of false alarms, the possible ambiguity of meaning of the alarm, and the tendency for people to look for confirming evidence

of a fire rather than to immediately evacuate are all factors which tend to determine the effectiveness of alarms in producing prompt evacuation. Several references are interesting in these regards. (e.g., 15, 38, 51, 87, 119)

Area of refuge

There is a general consensus among several researchers who have concerned themselves with high-rise occupancies that simple alarm systems are not adequate for many such occupancies. Total evacuation within a reasonable amount of time is not a feasible option. Comparatively complex voice communications systems have been instituted in some of these buildings so that partial, selective evacuations might be conducted. (56, 93, 108) This raises the interesting question of how willing people will be to wait their turn to evacuate or simply remain in a "safe area" once they are aware of the existence of a fire emergency. The fire in the World Trade Center on April 17, 1975, demonstrated that even though reassurances are provided through a public address system, it may still be difficult to convince people they are not in danger when they see an obvious problem such as smoke. In this case, a small trash fire in the fifth floor resulted in the evacuation of the 9th through the 22nd floor because of occupants' concern over smoke. The fire safety director had initially urged people to return to their offices; when it became obvious they were not going to do so, he ordered the evacuation. (83)

One aspect of partial, selective evacuations which could prove difficult is the condition where people working on the floor above a fire might be asked to go up a flight to prevent them from clogging narrow stairwells leading from the fire floor. It is to be expected that most people would want to go down stairs and leave the building.

However, Keating, Loftus, and Groner found in several buildings that there were no instances during test drills when people failed to follow the somewhat counterinstinctive direction to go up stairways, although several occupants were to question the sense of this directive. (92) (The occupants could not be certain that this was only a test.)

In large buildings without voice communications systems, occupants may be forced themselves to choose between using their living units as areas of refuge or attempting to evacuate. References with relevance here include: 21, 83, 89.

A recent trend has been to provide increased access to public buildings to the physically handicapped. The elevators used to provide access for these individuals under normal conditions commonly are not designed to be used in the event of a fire emergency. Thus there are increasing recommendations to establish adequate areas of refuge in these buildings. It will be necessary to inspire confidence in the adequacy of such areas.¹

Panic

Probably no word has been used more commonly than panic to refer to behavior in fire,² nor has any word been more tantalizing or frustrating

¹ See reference 89 for a major reference on fire safety and the handicapped. This publication is a product of a Conference on Fire and Life Safety for the Handicapped held at the National Bureau of Standards on November 26-29, 1979.

² Why the popularity of the notion of panic as a cause of fire deaths? Keating and Loftus mention one possible explanation which may be found in a theory of social psychology. Attribution theory suggests that "when the failures of others threaten the stability and predictability of our own world, we try to distance those failures from ourselves. Thus we tend to dismiss accidental fire deaths as the victims' fault: they panicked, but we would not..." "we often want to believe that the dead or injured were victims of their own maladaptive or panic behavior." (79a, p. 14)

to the behavioral researcher. The basic problem lies in the diffusion of meaning of the word. It has been used at various times to refer to emotion and/or action; to flight behavior alone, or to jumping or immobility reactions; to the initial reaction of an individual to a fire situation, or to the "stampede" of a crowd as smoke and flames rush into a room with inadequate or blocked exits. Panic can refer to actions which might be labelled maladaptive or adaptive, rational or irrational, depending upon the outcome of the actions or whose survival is being considered. With this complexity in mind, Quarantelli, as chairman of a panel on panic at an international seminar on behavior in fires, posed the following question to the assembled panel of experts: Do you see the concept of panic as a useful one for scientific purposes? (115)

The feeling of the panel was that the concept was exceedingly troublesome, but its use inescapable due to the long tradition of use and its frequent appearance in press accounts.

Behavioral scientists can take a nonscientific word like panic and attempt to attach an operational definition to it for study purposes. But even here there are intricacies as, when one attempts to attach modifying words, like "irrational" or "maladaptive" to actions like "flight." What may seem like "irrational" behavior from the point of view of an outside observer (with his hindsight and access to more complete knowledge of the total situation) may have been rational behavior from the point of view of the participant (98, 125); what is "maladaptive" for the welfare of the group (with the goal of saving the greatest number possible) may be adaptive for a given individual. Movement within a burning building against the press of an exiting crowd by a parent attempting to find a child is adaptive from the parent's viewpoint, but not for the group of people trying to get out.

Should the behavior of the two students who jumped from fifth floor dormitory windows, receiving serious injuries, be labelled as "panic?"

(30) Note that both of these individuals before jumping had experienced unsuccessful evacuation attempts, receiving burns in the process.

The Beverly Hills Supper Club fire in Southgate, Kentucky on May 28, 1977, in which 165 people died, is a case where a superficial look might lead one to ascribe many fatalities to panic. Sime quotes a British newspaper report with the headline "Panic Kills 300." (125, p.63) Contrary to this, researchers agree that panic, in the sense of aggressive behavior which would add to the danger to self and others presented by the fire itself, did not occur.¹ Rather "it seems reasonable to conclude that there was a maximum of altruistic behavior." (137, p.74) The essential behavioral problem lay in failure to appreciate the seriousness of the situation soon enough--there was a false sense of security felt by the fact that the Cabaret Room where most of the patrons were located was a long way from the room of fire origin. "Hence fire safety education should consider people's erroneous conceptions about distance being related to safety and the time needed to escape from a fire emergency." (137, p.108) Some patrons initially regarded the busboy's announcement of fire from the stage as a part of the comedy routine.

Sime maintains that "Research of fires shows that people need sufficient information about a fire before they can or are prepared to leave a building. There is growing evidence that the delay in warning people in a number of major fires has been a primary reason why people

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Bryan asserts that the existing physical evidence of human behavior after a fire when carefully examined can provide indications of adaptive or non-adaptive actions. In the panel discussion on panic at the Second International Seminar on Behavior in Fires, he pointed out that most of the bodies from the Beverly Hills fire were not bruised, did not have clothing torn off, did not have cuts...

have been unable to escape in time. An emphasis on avoiding 'panic' contributes to delays." (126, p.214) Any hesitation to inform people of a potentially dangerous situation out of fear of causing panic may ironically lead to a situation in which panic (i.e., rapid, mass competitive flight) must inevitably occur.

A better focus of concern would be what might be considered the reverse of panic--inaction, denial, a fear of appearing foolish by overreacting, the need to investigate before leaving a burning building, re-entry of it, or persistence in fighting a fire too large to control rather than promptly leaving. The Wood and Bryan surveys (147, 19) revealed considerable re-entry behavior. In Scanlon's study (119), people re-entered an apartment building to get possessions after reaching safety even after having seen smoke and flames while outside in the courtyard. The classic experimental studies of Latané and Darley (82) are interesting in that they indicated that the presence of others lessens the chances of an individual reacting promptly to a potential emergency. Male undergraduate subjects found themselves in a smoke-filling room. When alone, 75% of the subjects reported the smoke. In the presence of two nonreacting others (confederates of the experimenters) only 10% of the subjects reported the smoke during the experimental period.

Behavioral Tendencies

One strong pattern identified by the literature is the tendency of people in fires to do the familiar: they use familiar exits; they assume familiar roles.

Swartz found evidence in his behavioral study of the Beverly Hills fire that the people involved continued to fulfill the roles they had

prior to the fire. In that fire, the staff consistently took actions to assist patrons, whereas patrons followed or took a more passive role. Staff members took care of the patrons they would normally serve. Thus Swartz concludes that "firesafety plans for places of public assembly should examine the roles that people normally play, and not seek to prescribe emergency actions that are contrary to these roles." (137, p.108)

Bryan's extensive study of nursing home fire incidents (27) showed that nursing staff perform in accordance with their role of responsibility for patients even when at some risk to themselves.

Behaviors in accordance with traditional male/female roles have been identified by several researchers. For example, a University of Surrey study (38, pp.120, 122) found that the "variability of the actions which follow the encountering of the smoke and fire itself is explained by male/female differences. Females are more likely to warn others and wait for further instruction (for example, if husband and wife are both present). Alternatively they will close the door to the room of fire origin and leave the house. In both cases, females are more likely to seek assistance from neighbours. Male occupants are most likely to attempt to fight the fire. Male neighbours are more likely to search for people in smoke and attempt a rescue." The Wood study (148) revealed sex differences--women were again more likely to warn others and evacuate the family while men were more likely to attempt firefighting. Conventional sex role behavior was also found in the Bryan (19), Keating and Loftus (79a), and Kobayashi and Horiuchi (81) studies.

Another strong behavioral pattern identified is the tendency of people to seek verification of fire cues (both those which are characteristics of the fire, and alarms) before evacuating. There is also the problem of non-response due to negative conditioning by false alarms. Some of the relevant references here are: (15, 38, 51, 87, 119).

Decision-making

With very limited time available in which to decide on a course of action, people involved in fires often face difficult decisions: intellectually difficult in the context of limited knowledge of the engineered safety or of the basic configuration of the occupied structure or limited knowledge of the development of the fire itself; difficult due to the sometimes counter-instinctive nature of the correct response; or difficult due to the fact that some additional risk to one's self is incurred by a decision to alert or assist others. Further complicating matters is the possible negative physiological/psychological effects of toxic gases or oxygen deprivation even before these factors produce severe physical symptoms. (58, 112, 134a)

In an Illinois nursing home experimental study (70), it was found that staff were resistant to accepting the concept that ambulatory patients should be evacuated first. A group which received training on the home's fire emergency plan scored significantly better than a control group on test items regarding simple factual information relevant to fire safety, but no significant difference was found between the training and no-training groups with regard to the question of whether to evacuate ambulatory or non-ambulatory patients first. A majority of both groups incorrectly indicated that non-ambulatory patients should be evacuated first. The experimenters concluded that, in instances like this, where there are strong erroneous preconceptions regarding appropriate behavior in fire, more thorough training methods, including simple explanations of why such beliefs are in error, are needed.

Nursing staff in a Mississauga, Ontario nursing home fire (49a), which resulted in 25 patient deaths, were faced with the problem of

trying to save a patient in the room of fire origin. When the nurse arrived at this room, several items, including the bed and chair, were on fire. She could not enter the room, but was aware of the patient still in there, lying on the floor moaning. She closed the door and reportedly went to get wet sheets and blankets to attempt to remove the patient. A supervisor returned to the room, reopened the door, but unfortunately was unable to close it again due to the great volume of fire and smoke.

The degree of altruism and capability exhibited by people in some of the case studies is perhaps surprising. Some cases in point: the behavior of the nurse's aide in the St. Joseph's Hospital fire (24), the evacuation assistance rendered by a resident of the Taylor House to another blind resident (29), and the instances of occupants assisting other less able occupants in the Georgian Towers apartment fire (21).

Summary

Research directions and preliminary findings

This introduction has served to acquaint the reader with the broad range of research done in the area of human behavior and fires, to give an overview of human response patterns to various fire safety design features, and to, wherever possible, point out some areas where various researchers have arrived at similar findings regarding behavioral tendencies in response to fire emergencies.

"Panic" behavior has been singled out for special attention. Whether or not "panic" occurred in a given situation to some extent seems to depend upon the definition one assigns to panic. However, the

concept of panic is too prevalent and too important to be dismissed merely as a semantic matter. Panic is no doubt the behavior most commonly associated with fire emergencies by the public in general and historically by those with professional interests in fire safety. Institutional fire safety plans and general safety guidelines to the public routinely and repeatedly warn against panic.

Researchers now tend to discount the importance of panic as a factor which adds to the injuries or loss of life which would result from the fire itself. [An early research study (20) is interesting in that panic behavior is an assumption, not a condition to be defined or verified.] It is important to distinguish between panic, as an emotion, and panic, as an action with aggressive, maladaptive, or irrational components. People naturally feel strong anxiety in a fire emergency, but this strong emotion does not necessarily preclude appropriate life-saving actions.¹

The consensus among disaster researchers at the human behavior in fires conference in 1978 was that the popular belief in the widespread prevalence of panic in disasters in general is a "myth." Some caution is perhaps in order, as Black pointed out during the discussions, when generalizing this downgrading of the importance of panic reactions in disasters to fire emergencies. Because of the extremely limited time for reaction and the possibility of sensory deprivation, fires may present a special category of disaster.

Although evidence of panic reactions should continue to be looked for by fire investigators and researchers, it has been suggested that

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Reference no. 74 provides an interesting theoretical analysis of the possible relationship between anxiety and appropriate behavioral action.

more attention to other potentially harmful behaviors such as failure to respond to alarms or re-entry of a burning building may prove more useful.

Decision-making during the various stages of a fire emergency can present a severe challenge to the participants. Since every situation is somewhat different, successful coping with a fire emergency can demand more of the participant than following a set of previously memorized correct actions. It has been suggested that analysis of the decision-making process, based on in-depth interviews with participants, is one direction which might be emphasized in future research.

Prediction and risk

An important goal of behavioral research is to understand the capabilities of people in fires and to be able to predict their likely reactions in emergencies. The extent to which human behavior is predictable (even with improved knowledge) is still an open question. Since human response in a fire emergency tends to be difficult to predict (individuals vary from one another and also a given individual's performance may vary with the time and setting), it can be argued that an ideal system of fire safety might be one in which there was no dependence on human response, and the approach could be classified as "idiot proof." In a practical sense, however, there is no safety system that cannot be enhanced by appropriate human actions or defeated by inappropriate actions. To some degree, human response can compensate for shortcomings in the physical safety of the environment and vice versa. Each, however, has an area of participation in overall safety that is not interchangeable with the other.

The appropriate balance of all safeguards, both physically installed and human response in nature, is needed. In this balance, all factors--including potential safety, reliability, failure mode and effect, cost and other impacts--need consideration. Absolute safety against fire injury and death is, of course, unattainable. Authorities must implicitly accept a certain "reasonable" level of risk when they make decisions in the area of resource allocation for fire safety. (Several references pertinent to this general topic are listed under "risk" in the index.)

With regard to vulnerable populations--the aged, the physically handicapped, and the mentally impaired, the acceptance of a certain degree of risk is done with the intent of improving the "quality of life." Such individuals have been moved from institutional settings--with greater built-in fire protection--to smaller residences with more homelike atmospheres. (See reference number 70a for a discussion of deinstitutionalization and the major implications of this trend for fire safety.) Greater access to public buildings has been provided for the handicapped through ramps and elevators, placing them at greater risk from fire, but improving their freedom of movement. Burgun maintains that the handicapped should be allowed to take the kinds of risk we all accept as part of normal life, since if all elements of risk are denied handicapped persons, then essential developmental opportunities are also denied. He also contends that the handicapped should not have to endure more or increased risks than those who are not disabled, and that some special provisions will therefore have to be made for the handicapped.

(33)

Determination of the appropriate share of the limited funds available for social concerns to devote to life safety from fire, and consideration

of the proper balance between "reasonable" safety from fire and "quality of life" are two of the complex, underlying philosophical challenges which face administrators and fire officials.

TOPICAL INDEX

This index can provide an initial guide to the human behavior and fires literature. References pertaining to various occupancies, research approaches, or the different stages and types of response are indexed. The indexing is rough and preliminary: for example, some mention of "alarms" would be a feature of practically all the case studies of fire incidents, but a case study reference might not be indexed under alarms unless some feature of the alarm system was particularly important to the outcome of the incident.

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* in a broad sense -- including homes for the developmentally disabled, hotels for the elderly, half-way houses, board and care homes for the mentally retarded and aged.

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1. Appleton, I. The Requirements of Research into the Behaviour of People in Fires. In: Fires and Human Behaviour, edited by David Canter, Chapter 2, pp. 13-30. New York, John Wiley & Sons, 1980. 338 pages.

A variety of fire statistics for the United Kingdom for the years 1965-1976 are presented. These include data on financial losses, number of fires in various occupancy types, ignition sources in occupied buildings, and number of casualties--fatal and non-fatal. Some international fire statistics are presented for comparison.

Governments attempt to deal with the losses represented by these statistics through regulations. Regulations should be formulated from assumptions derived from fire data on buildings and their contents, and on people and fire behaviors. In developing objectives for regulations, the safety goals should be stated in terms of performance objectives (i.e., the probability that one person is killed by fire per annum in a building), rather than in terms of standards for specific components of a building. The performance requirement itself must be determined from what society regards as an acceptable risk for that particular setting. The author describes the efforts being made by the British Fire Research Station to meet the research needs of the above scheme for coping with fire losses.

Index Words: Fire fatalities; fire incident statistics.

2. Archea, J. and Margulis, S.T., Editor. The Evacuation of Non-Ambulatory Patients from Hospital and Nursing Home Fires: A Framework for a Model. National Bureau of Standards Report No. NBSIR 79-1906. November 1979. NTIS Order No. PB 80-119530.

This is an analysis of the evacuation process in nursing homes or other health care facilities where large numbers of dependent, non-ambulatory patients are involved. The factors which must be considered in developing evacuation plans and assessing their worth are identified.

The evacuation process is divided into 5 sequential phases: (1) the manpower supply phase, (2) the patient preparation phase, (3) the patient removal phase, (4) the rest and recovery phase, and (5) the manpower resupply phase. In each phase, the relevant patient, building and staff factors (including decision-making ones) are detailed. Five overall system parameters are identified: Fire development, weighted mobility status, spatial distribution of patients and staff, task proficiency and manpower organization. These parameters are presented as a starting point for the modeling of evacuation systems for non-ambulatory patients in health care facilities.

An extensive research agenda for developing further understanding of the evacuation process is provided. Such research would fall

into three broad categories: (1) initial condition measures (determination of the normal positions and/or status of the building, staff, and occupants), (2) performance measures (determination of the levels of performance required for a successful evacuation and the levels of staff and patient capabilities), and (3) intermediate protection and evacuation trade-offs (effectiveness of protect in place vs. evacuation).

Index Words: Conceptual model; egress model; evacuation; fire emergency planning; hospitals; literature review; nursing homes.

3. Baker, G.W. and Chapman, D.W., Editors Man and Society in Disaster. New York, Basic Books, Inc., 1962. 442 pages.

This is a general background reference on the behavior of individuals and groups in response to the stresses imposed by natural or man-made disasters such as bombings, tornadoes, or fires. Both research methods and models and specific subjects such as the family, the aged, and the community in disaster are covered.

The Committee on Disaster Studies was established in 1952 by the National Academy of Sciences and its component member, the National Research Council. This book is an outcome of the work of the Committee.

Index Words: Conceptual model; evacuation; panic.

4. Baldwin, R., Melinek, S.J. and Appleton, I.C. Evacuation of Buildings. In: International Fire Protection Seminar, 5th. Vol. 2, pp. 71-83. Sponsored by the Vereinigung zur Forderung des Deutschen Brandschutzes e.V. Karlsruhe, West Germany, September 22-24, 1976.

This paper examines some of the data underlying the calculations of exit capacity and escape times from buildings in evacuation standards. Data on crowd movement are used to predict the time necessary to evacuate buildings of varying dimensions and densities of occupation. These calculations are then compared with data on evacuation of buildings in experimental situations, fire drills, etc. The cost implications of escape requirements in buildings are examined. Data based on the movement of normal, active people, are contrasted with some recent experiments in hospitals where problems are encountered in evacuating handicapped patients within an acceptable time.

This paper also describes the constraints regarding capacity and layout of exits upon which existing United Kingdom codes of practice are based. One requirement--that compartments should be evacuated to a place of safety within 2 1/2 minutes--was based upon the psychological assumption that 2 1/2 minutes was felt to be the longest people would be prepared to wait without panic.

Index Words: Codes and standards; egress model; evacuation; handicapped; hospitals; panic.

5. Beard, A.N. A Suggested Methodology for Approaching Fire Safety and Its Relation to Fault-Tree Analysis. In: Second International Seminar on Human Behavior in Fire Emergencies, October 29 - November 1, 1978 -- Proceedings of Seminar, pp. 3-12. National Bureau of Standards Report No. NBSIR 80-2070. Issued June 1980. NTIS Order No. PB 80-204738.

Fire safety (or lack of it) is the end result of the working of an entire system. A possible methodology for analyzing and evaluating such a system is presented.

The methodology is broken down into eight sequential steps (for example--formulation of the problem, development of models, examination of specific failure situations, generation of ideas to solve the problem, carrying out of possible solutions, and appraisal of results). The process is never "closed;" at any point the need may arise to return to earlier steps and repeat the sequence with new or revised ideas.

One of the techniques which might be used at the modeling step is fault-tree analysis. This is a method by which failures that can contribute to an undesired event are organized logically. The various factors and events which contribute to a major failure, when arranged schematically, present a tree-like structure with the most undesired event being at the final convergence of all the branches. Branches (factors) may be connected by "and" or "or" gates: an "and" gate means all input factors must be present to produce the failure while an "or" gate means just one or more of the factors will produce the failure.

Use of fault-tree analysis with regard to fire development is more complex than its use in some "hard" engineering systems. The logical connections in the fire development tree depend upon time in a very complex way, and this complicates the modeling. Also, there are a very large number of elements to consider involving material properties, geometry, and people's behavior. Nevertheless, a preliminary attempt to use fault-tree analysis to model fire development is made, using the fire incident at Coldharbour Hospital in July 1972 which resulted in 30 fatalities. First, the system as it existed at Coldharbour is modeled probabilistically; then, alternative systems which would represent a few fire safety measures having been taken are modeled.

Index Words: Conceptual model; fire incident study; hospital.

6. Bell, J.R. Fourteen Die in Ohio Boarding Home Fire. Fire Journal, Vol. 74, No. 4, 28-31, 87, July 1980.

Fourteen people died in a fire at the Coats Rooming House in Pioneer, Ohio on November 11, 1979. The 100-year-old, two-story boarding home provided room and board for eleven elderly private residents and eight mentally retarded residents referred to the

boarding home after release from a state mental health care facility. Two apartment units in the building had an additional five occupants. The fire originated in one of the apartment units in a sofa on which two children had been sleeping.

Factors contributing to the large number of fatalities include: combustibile interior finish, heavy fuel loading, lack of compartmentation, a single means of egress from the second floor, and an apparent lack of reponse of some of the residents to fire conditions.

The building had been operated as a nursing home from 1958 to 1973, when the state of Ohio adopted NFPA 101, the Life Safety Code, for Intermediate Care Facilities. The home could not meet the requirements and was converted to a rooming and boarding house. Code requirements for this type of occupancy were left up to the local jurisdiction; in this case, there were no local requirements that had to be met.

Index Words: Codes and standards; boarding home; fire fatalities; fire incident study; handicapped.

7. Bell, J.R. Halfway House Fire in Washington, D.C. Kills Ten. Fire Journal, Vol. 74, No. 2, 45-47, 50-53, March 1980.

This is an account and analysis of the fire on April 11, 1979, at a community residence for psychiatric outpatients in Washington, D.C. Of the 21 residents in the east side of the duplex structure in which the fire originated, 10 died. Of all the factors contributing to the fatal outcomes, two--the lack of a stairway enclosure and the lack of a second means of egress to allow escape from the second and third floors--produced an overwhelming degree of hazard that could not be overcome by other safety features present.

There is a discussion of the rather complex situation which existed regarding licensing and enforcement of applicable codes. On August 5, 1977, the District of Columbia amended its "Health Care Facilities Regulation" by the "Community Residence Facilities Licensure Act of 1977." This amendment defined community residences. In general, these residences are those which provide a sheltered living arrangement for those who are ambulatory and able to perform activities of daily living with minimal assistance. The regulation amended the District of Columbia "Building Code" to include by definition a "community residence facility housing more than 15 residents as an L-1 Residential Occupancy." The inspections and licensing program for community residence facilities which was consolidated under the city's Department of Human Resources (DHR) was not put into effect because DHR lacked money and personnel. In August 1978, the Department of Economic Development issued a Certificate of Occupancy for use of the structure for the purpose of "Room and Boarding for Adults - 51 persons," although it was later determined that the building did not meet DC "Building Code" requirements. Within the three months prior to the August certification, the building had been inspected three different times--first, by personnel from the Buildings Inspection Department, then by the DHR, and finally, by the Fire

Marshal Division of the DC Fire Department. If the requirements of the "Building Code" or the "Community Residence Facilities' Licensure Act" had been met, either a second interior stairway or an exterior stairway or fire escape would have been required. However, the author believes that their effectiveness as second means of egress would have been jeopardized by the unenclosed stairway which allowed rapid heat and smoke buildup in the hallways.

See also reference: Bryan, J.L., Milke, J.A., and DiNenno, P.J. An Examination...Taylor House...

Index Words: Codes and standards; alarms; boarding home; evacuation; fire extinguishers; fire fatalities; fire incident study.

- 7a. Bell, J.R. 24 Die in New Jersey Hotel Fire. Fire Journal, Vol. 75, No. 2, 57-63, 98, March 1981.

On July 26, 1980, a late evening fire in a residence for the elderly and mentally impaired in the town of Bradley Beach, New Jersey took the lives of 24 of the 38 residents of the facility. The fire, probably of electrical origin, started in a concealed space above the ceiling of a basement recreation room.

The Brinley Inn was licensed by the state as a hotel. No regular care of any kind was provided for residents. The owners had petitioned the state for permission to turn the hotel into a "shelter-care" facility but dropped the petition when the state required extensive improvements to meet licensing requirements.

The primary factor that contributed to the fatalities was an unenclosed stairway running from the first to the third floors on the south end of the residence, which ended in an unprotected first floor lobby. Additionally, the manager, alerted by the activation of the fire alarm system, opened the door of the basement to investigate and left the door open. Thus the fire was allowed to spread quickly from the basement to the second and third floors.

Other factors contributing to the fatalities were: the lack of an early warning fire detection system, the lack of an approved second means of egress, and louvered guest room doors.

The origin and propagation of the fire in the concealed space above the basement ceiling delayed response of the heat detection system in the room of fire origin. Enough smoke reached a third floor smoke detector to activate it before the alarm was initiated by the heat detection system. By the time the heat detection system activated, residents were faced with rapidly deteriorating conditions.

There was a lack of an acceptable second means of egress from the second and third floors. The corridor on the second floor did have a north exit door that led to the flat roof of a one-story kitchen extension. A very steep metal fire escape provided the second means of egress from the third-floor corridor to the kitchen roof. A vertical metal ladder attached to the building provided the only access from this roof to the ground level below. Reportedly, these exits had not been used during twice monthly fire drills conducted at the Inn because of the danger to the elderly in trying to navigate these exits. During the fire, police and firefighters helped some residents who were standing on the roof climb down the ladder to the ground.

Some residents who remained in their rooms were rescued. However, others died as smoke entered the rooms through louvered doors.

Index Words: Alarms; boarding home; fire drills; fire fatalities; fire incident study; handicapped.

8. Berl, W.G. and Halpin, B.M. Human Fatalities from Unwanted Fires. The Johns Hopkins University, Applied Physics Laboratory. National Bureau of Standards Report No. NBS-GCR-79-168. December 1978. Final Report. NTIS Order No. PB-295411.

This study presents some worldwide demographic information on human fire fatalities, and then details findings from a study of 463 fire fatalities during 1972-1977 in the State of Maryland.

There are marked differences in fire fatality rates among various countries, and, within the U.S., among the various states. Efforts to account for these wide differences by correlation with various social or economic indicators have proved difficult.

In the Maryland study of fire fatalities, the factors of age, location, sex, race, and drugs (alcohol) were considered. Some findings from the Maryland data are: the likelihood of being a fire fatality is somewhat elevated in the age group 0 - 9 and highest in the age group 60+; high consumption of alcohol by men seems to increase the probability of becoming a fire fatality; and black children in the age group 0 - 9 are at particularly high risk. Data are presented on the medical consequences to the victims as found from detailed autopsies and on the physical causes of the fatal fires. Ignition by cigarettes was the most damaging single cause.

Index Words: Fire incident statistics; fire fatalities.

9. Berlin, G.N. A Modeling Procedure for Analyzing the Effect of Design on Emergency Escape Potential. In: Second International Seminar on Human Behavior in Fire Emergencies, October 29 - November 1, 1978-- Proceedings of Seminar, pp. 13-41. National Bureau of Standards Report No. NBSIR 80-2070. Issued June 1980. NTIS Order No. PB 80-204738.

A technique which can be used to analyze the effects of a building's design on emergency escape potential is presented. The technique

is used to calculate the number of directed escape routes both initially and during various stages of a fire as the opportunities for escape change due to the spread of flame and accumulation of combustion products. It assumes that the extension of a route is always directed toward a designated location of safety and that opposing movement through a room is prohibited. "Backtracking" and "circling," in which an occupant passes through the same room more than once, are not allowed in this definition of an escape route.

The layout of the Beverly Hills Supper Club in Southgate, Kentucky, which was the site of a fire on May 28, 1977 resulting in 165 fatalities, is used to illustrate this technique. The floor plan of the Club and an accompanying "escape graph" showing the possible directed escape routes for pre-fire conditions are given. A table shows the number of directed escape routes from each of the various locations in the building before the start of the fire and during three different time periods of the actual fire.

Index Words: Egress model; evacuation; fire fatalities; fire incident study.

10. Berry, C.H. Will Your Smoke Detector Wake You? Fire Journal, Vol. 72, No. 4, 105-108, July 1978.

Various research findings regarding the dBA level necessary to awaken subjects in differing sleep stages are cited. Determination of an effective dBA level for detectors is complicated by the fact that not only do individuals vary fairly widely in regard to the dBA level necessary for awakening, but the same individual has differing thresholds under different sets of psychological and physiological conditions. The level of 75 dB might be regarded as a minimum level that should arrive at the ears of a "normal" person. The problem of high background noise level is considered. It is possible to conclude intuitively that as the difference between background noise level and alarm level decreases, so does the likelihood that the alarm will waken the person. An "awakening" worksheet is presented which the homeowner might use to determine the probability that his detector alarm will awaken him in an emergency. It includes such factors as distance from sleeper to alarm and number of normally closed doors between sleeper and alarm.

Index Words: Alarms; smoke detectors.

11. Best, R. The Wincrest Nursing Home Fire. Fire Journal, Vol. 70, No. 5, 12-15, September 1976.

A fire occurred in the Wincrest Nursing Home in Chicago, Illinois, on January 30, 1976 which resulted in 24 fatalities from among 83 residents. The fire originated in a wooden clothes wardrobe in a patient room. All of the residents who died with the possible

exception of 2 were located in a chapel on the same floor. A nurse shut the door to the room of fire origin but subsequently the door was left open after futile attempts by a priest and a maintenance man to extinguish the fire. This open door and the open corridor to the chapel allowed the fatal spread of the smoke and toxic gas.

Index Words: Fire fatalities; fire incident study; nursing home.

12. Bickman, L., Edelman, P. and McDaniel, M. A Model of Human Behavior in a Fire Emergency. Loyola University of Chicago. National Bureau of Standards Report No. NBS-GCR-78-120. December 1977. Final Report. NTIS Order No. PB-277773.

The model of human behavior in a fire emergency proposed consists of 3 stages: detection of cues, definition of the situation, and coping behavior. In this model, the individual is depicted basically as a reactor to the environment; however, instances are included in the fire coping stage in which the individual impacts on the environment. The focus is upon the individual's perceptions of the situation, not the absolute reality of it, as a determinant of behavior.

The 4 broad categories of cues (stage 1) are: characteristics of the fire, alarms, indications from others, and alarm-indications from others (refers to prerecorded messages activated during a fire as might be encountered in a high-rise building). In stage 2, the individual evaluates the cues and may define the situation as "fire," "no fire," or "possible fire." For stage 3, 10 exhaustive categories of fire coping behaviors are described. These are: suppress/contain fire, warn/rescue others, activate alarm system, protect self, remove property from fire, seek information, prepare for further action, panic, escape, and no action. Finally, the author lists and expands upon a number of factors which influence the individual throughout these three stages. These determinants of behavior may be classified as: physiological/physical, intrapersonal, education/preparation, social, fire characteristics, and physical environment. The way in which the model may be used is illustrated.

Index Word: Conceptual model.

13. Bickman, L., Herz, E., Edelman, P. and Rivers, D. An Evaluation of Planning and Training for Fire Safety in Health Care Facilities--Phase Two. Loyola University of Chicago. National Bureau of Standards Report No. NBS-GCR-79-179. January 1979. Issued August 1979. Final Report. NTIS Order No. PB-299023

This experimental study evaluates the effectiveness of a single, one-hour training session for nursing home staff in improving recipients' knowledge and behavior with regard to fire emergencies.

Six nursing homes in Evanston, Illinois were randomly assigned to experimental and comparison groups. The research design involved the use of a knowledge survey before training, a training session

consisting of a 10 minute slide show and a 45 minute lecture (given to staff in experimental homes only), and the use of a different form of the knowledge survey after completion of the training sessions. Two observation sessions of fire drills in each nursing home were held both in the experimental (training) and comparison (no-training) homes--one observation before and one after the time of the training period. The drills were analyzed from the point of view of content (the execution of appropriate actions) and time (the speed with which the actions were accomplished).

Results indicated that training increased knowledge in the experimental group as expected. Various threats to the internal and external validity of the experimental design were ruled out, on a statistical basis, as plausible alternative explanations for the training effect. The results of the fire drill behavior analyses also indicated a measurable positive impact of training on the overall behavior of the experimental group during the post-training fire drills.

Throughout this report, the many problems in a study of this nature are described. For example, it was considered desirable to have the drills initiated by the discovery by a staff member of a "fire flag" to simulate a real fire occurrence in a given location rather than by having a drill initiated by sounding an alarm. However, many of the individuals involved did not react to the discovery of a "fire flag," and several of the fire drills conducted had to be initiated by the pulling of an alarm.

It is suggested that one means of improving the training procedure might be to use, in addition to the lecture format session, a role-playing session in which the staff act out the behaviors involved in a fire situation.

The fire emergency plans of the six nursing homes in the study were rewritten in order to improve both content and organization. The appendix of the report contains a set of guidelines for developing fire emergency plans for nursing homes.

Index Words: Experimental study; fire drills; fire emergency planning; nursing homes; training and education.

14. Black, C.M. Panic: Some Anthropological Insights. In: Second International Seminar on Human Behavior in Fire Emergencies, October 29 - November 1, 1978 -- Proceedings of Seminar, pp. 204-206. National Bureau of Standards Report No. NBSIR 80-2070. Issued June 1980. NTIS Order No. PB 80 204738.

Panic is seen as a remnant of our evolutionary past, one which became maladaptive with the advent of civilization. The subjective and objective aspects of panic are explored with the aim of presenting a working definition. The subjective aspects include: acute fear,

perception of a crisis, loss of ties to others, confusion, extreme frustration, a sense of chaos and a feeling of entrapment. The objective factors include: flight, contagion and a variety of other behavioral responses. It is suggested that panic behavior develops in a number of stages. There is a pre-panic condition in which people feel "panicky" but do not actually panic. This can lead to "partial panic," a state in which some forms of social behavior may still occur. Finally, there comes total panic during which there is complete loss of self-control and all sense of others is obliterated. Areas where intensive work is needed include the following: sophisticated debriefing of people who engage in panic done by an interdisciplinary team; work in the area of design; more knowledge about the role in panic of the different components of a fire situation; and better understanding of the role of leadership in reducing a sense of chaos.*

*Annotation is based on author's abstract with modifications and/or additions.

See also reference: Quarantelli, E.L. Five Papers...

Index Word: Panic.

15. Breaux, J., Canter D. and Sime, J. Psychological Aspects of Behaviour of People in Fire Situations. In: International Fire Protection Seminar, 5th. Vol. 2, pp. 39-50. Sponsored by the Vereinigung zur Forderung des Deutschen Brandschutzes e.V. Karlsruhe, West Germany, September 22-24, 1976.

This report outlines a preliminary model for behavior in fires centering around 3 process states: (1) Recognition/Interpretation/Verification (2) Behaviour (Action/No Action) and (3) Outcomes (Evaluation and Long Range Effects). The report concentrates upon the initial stage of recognition/interpretation. There is a discussion of cues, both direct (perception of noise, smoke) and indirect (visual or auditory perception of others behavior). The manner in which a person recognizes a fire and takes action is also dependent on past experience and "current state factors," (e.g., the activity he is engaging in at the time of the fire).

To date, the Surrey Fire Research Unit had collected over 80 interviews relating to about 16 events. In nearly all incidents surveyed, there was an initial reluctance by the "discoverer" to equate fire cues with the actual presence of a fire. Noise cues typically tend to be attributed to events more probable than a fire. In a number of cases people needed to verify for themselves more precisely that there really was a fire even when the first cue or cues were particularly suggestive--e.g., smoke and smell.

Index Words: Conceptual model; fire incident study.

16. Bryan, J.L. Human Behavior in Fire - A Bibliography. University of Maryland. National Bureau of Standards Report No. NBS-GCR-78-138. August 1978. NTIS Order No. PB-287412.

This is a listing of 245 references pertaining to human behavior in fire. This bibliography was used as a source for some of the references in the present bibliography.

It "was originally prepared for the Third Joint Panel Meeting, United States - Japan Natural Resources Panel on Fire Research at the Center for Fire Research, National Bureau of Standards, March 13-17, 1978. The bibliography was revised as the result of additional literature reviews during August, 1978. The previously developed bibliographies of Dr. Leonard Bickman, Fire and Human Behavior Research Center, Applied Social Psychology Program, Loyola University of Chicago; Fred I. Stahl and John Archea of the Center for Building Technology, National Engineering Laboratory, National Bureau of Standards; J.L. Pauls of the Division of Building Research, National Research Council of Canada; and Dr. Tadahisa Jin, Fire Research Institute, Fire Defense Agency, Ministry of Home Affairs, Japan, were valuable sources of citations."*

*from author's abstract

Index Word: Bibliography.

17. Bryan, J.L. Human Behavior in the Fire Situation. Journal of Fire and Flammability, Vol. 6, 17-27, January 1975.

The many, complex, interrelated variables which influence human perception and response during a fire threat are considered. These variables are grouped into five basic areas: the characteristics and location of the fire which determine the person's estimate of the severity of the situation and the time available for response; the basic characteristics of the building; the type, suitability, response time and effectiveness of its fire protection systems; the physical and psychological nature of the individual and his cultural and experiential background; and the structure and nature of the building population.

Index Word: Conceptual model.

18. Bryan, J.L. Panic or Non-Adaptive Behavior in the Fire Incident, An Empirical Concept. In: Second International Seminar on Human Behavior in Fire Emergencies, October 29 - November 1, 1978 -- Proceedings of Seminar, pp. 206-208. National Bureau of Standards Report No. NBSIR 80-2070. Issued June 1980. NTIS Order No. PB 80 204738.

Panic as a term appears to have value in communicating with the public and with obtaining support for investigations and studies.

As a basis for scientific study, it does not appear to be as useful as the concept of group or individual non-adaptive behavior. The existing physical evidence of human behavior following a fire incident (e.g., a damaged fire extinguisher) when carefully examined can provide indications of adaptive or non-adaptive behavioral actions. Non-adaptive behavior should not be applied solely to flight behavior, since any behavioral action in a fire incident may be adaptive or non-adaptive relative to the individual, the group, or the fire incident. The causes of non-adaptive behavior in fires are complex. We need to examine the pre-existing conditions in the group and the physical conditions and structure of the fire incident environment to identify favorable conditions for adaptive or non-adaptive behavior. The terminology or label we attach to the behavior is not critical so long as the term is operationally defined.*

*This annotation is closely based on the author's abstract with some modifications and/or additions.

See also reference: Quarantelli, E.L. Five Papers...

Index Word: Panic.

19. Bryan, J.L. Smoke as a Determinant of Human Behavior in Fire Situations (Project People). University of Maryland. National Bureau of Standards Report No. NBS-GCR-77-94. June 30, 1977. Final Report. NTIS Order No. PB-271755.

This extensive study statistically analyzes the interrelationships between various factors (sex of occupant, previous training, belief in safety of the building, etc., and, most particularly, perception of smoke) and the actions of people involved in fire incidents. 584 participants in 335 fire incidents which occurred between January 15, 1975 and April 30, 1976 in the Washington, D.C. and Baltimore, Maryland metropolitan areas were interviewed. A structured interview questionnaire form was used by fire department personnel at the scene of the incident. The most prevalent occupancy in the incident population was the single family dwelling.

Survey results indicated that the most frequently initiated first action consisted of the notification of other individuals and the choice of this action appeared unrelated to the sex of the notifier. In other first action categories, some statistically significant sex differences were found--i.e., males were more likely to "search for the fire" or "obtain an extinguisher."

The movement of the participant population through smoke was the critical concern of this study. Approximately 62.7% of the total participant population moved through smoke during the fire incidents included in this study. Interestingly, of the participant population which moved through smoke, 46.4% moved through smoke a greater distance than their visibility through the smoke. The author concludes that, in view of the large percentage of the participants

who moved through smoke, the presence of smoke, if it is not of sufficient density or irritant quality to force the participants to turn back, does not appear to deter the evacuation behavior. On the other hand, about 1/3 of the participants who moved through smoke did turn back because of the smoke or the combination of smoke and heat.

Results were compared with those of a similar study conducted by Wood in England. The results of the two studies were in general agreement, with the differences in large part explainable by the larger percentage of residential fires in this study.

Index Words: Evacuation; fire incident statistics; fire incident study; residential occupancies; smoke, influence of.

20. Bryan, J.L. A Study of the Survivors' Reports on the Panic in the Fire at the Arundel Park Hall in Brooklyn, Maryland, on January 29, 1956. Fire Protection Curriculum, University of Maryland, College Park, Maryland, 1957.

This report analyzes the fire which occurred on January 29, 1956, in the Arundel Park Hall in Brooklyn, Maryland at a church sponsored oyster roast. The hall was occupied by between 1100 and 1200 people; of these, 11 persons were killed and about 250 were injured. Data for the study was obtained from recorded interviews conducted by police personnel with 61 persons present when the fire occurred.

The primary purpose of the report was "to attempt to clarify some of the factors affecting the panic behavior that occurred..." After heavy smoke had built up and the lights went out, panic prevailed, in that, people fought for exits and many were knocked down or lost their footing and were trampled. (Many of the persons who had fallen to the floor were picked up and carried from the building.) Fallen chairs and overturned tables added to the confusion. Factors contributing to the panic behavior included: an initial period of delay when the fire appeared small and was attacked with extinguishers, giving the impression of a minor occurrence and thus, false security; the rapid spread of the fire once it appeared threatening, with a high rate of heat and dense smoke; the crowded condition of the hall; and the failure of the lighting system.

Thirty-eight of the persons interviewed were asked the question: "Did you notice if any of the doors had exit lights lit over them?" Only one of these persons stated that he knew the exit lights were on. The fact that so many persons (including firemen and policemen) did not notice the exit lights raises the question of the effectiveness of these lights for attracting the attention of people in places of public assembly.

Index Words: Evacuation; fire fatalities; fire incident study; panic; communications.

21. Bryan, J.L. and DiNenno, P.J. An Examination and Analysis of the Dynamics of the Human Behavior in the Fire Incident at the Georgian Towers on January 9, 1979. University of Maryland. National Bureau of Standards Report No. NBS-GCR-79-187. April 30, 1979. Issued December 1979. NTIS Order No. PB 80-148596.

This is an analysis of the human behavior and fire development in the fire incident at the Georgian Towers apartment complex in Silver Spring, Maryland which occurred on January 9, 1979. There were no fatalities; however about 21 occupants required emergency medical treatment, 17 for smoke inhalation. Data was obtained through the use of structured questionnaires and interviews. Of 416 questionnaires distributed to residents; 110 were returned. 23 interviews were held with residents; 8, with fire department personnel.

An occupant unsuccessfully attempted to remove the mattress in which the fire started from his second floor apartment and then left the apartment, leaving the door open, to run down to the receptionist desk to call the fire department. Flashover occurred in the apartment about the time of fire department arrival, but the fire did not extend beyond the immediately exposed second floor corridor area. Smoke permeated most of the building.

The alerting, information-seeking, and evacuation behaviors of other residents are described. The failure of the local alarm system to operate for an efficient period of time resulted in the occupants being alerted over an extended period of time by various sounds related to the fire incident rather than by the alarm. The fire department advised occupants to remain in their apartments until after extinguishment and ventilation. Apartments and apartment balconies were used by some residents as areas of refuge. Several persons used complex egress routes to reach an area of refuge after being unsuccessful at an initial evacuation attempt. The evacuation behavior and attempted evacuation efforts of some residents resulted in the majority of smoke inhalation cases requiring treatment. Instances of occupants assisting other less able occupants are recounted.

Index Words: Alarms; area of refuge; evacuation; fire incident study; handicapped; high-rise building; Lerup mapping technique; residential occupancy.

22. Bryan, J.L. and DiNenno, P.J. An Examination and Analysis of the Dynamics of the Human Behavior in the Fire Incident at the Kensington Gardens Nursing Home on January 1, 1978. University of Maryland. National Bureau of Standards Report No. NBS-GCR-79-159. June 30, 1978. Issued January 1979. Final Report. NTIS Order No. PB-290892.

The fire incident which occurred on January 1, 1978 at the Kensington Gardens Nursing Home in Montgomery County, Maryland is analyzed

using the Lerup mapping technique. (See Lerup references.) This fire which originated in an upholstered chair in a patient room was detected by a nurse's aide who was checking on a patient. All seven patients in the fire zone were rescued successfully--three of them by staff before conditions in the corridor became untenable, and four, by the fire department. The closing of the door to the room of fire origin and of the other patient room doors in the fire zone enabled all patients to survive despite the fact that conditions were untenable in the corridor approximately six minutes before the rescue of the last four patients by firefighters.

Index Words: Fire Incident study; Lerup mapping technique; nursing home.

23. Bryan, J.L. and DiNenno, P.J. An Examination and Analysis of the Human Behavior in the Fire Incident at the National Institutes of Health Clinical Center on April 21, 1979. University of Maryland. National Bureau of Standards Report No. NBS-GCR-80-192. January 1980. NTIS Order No. PB 80-177264.

This is a description and analysis of the serious fire incident which occurred at the National Institutes of Health Clinical Center, Bethesda, Maryland, on April 21, 1979. The fire involved the entire area of a ninth floor solarium lounge and spread down the corridor for a distance of about 50 feet. Smoke spread through many areas of the building, eventually spreading from the seventh to the fourteenth floors. All the patients and visitors in the third to the fourteenth floor areas of the building were evacuated to the first and second floors and to the exterior. There were no fatalities. However seven persons were hospitalized for medical observation or treatment as a result of the fire: four fire department personnel, one police officer, one visitor, and one patient.

The occupancy of the unit of fire origin at the time of the fire consisted of six patients, two visitors, and three nurses. In the context of the rapidly developing fire, nursing staff evacuated four ambulatory patients and two visitors from the unit, leaving behind one ambulatory 18 year old and an infant. Staff informed maintenance engineers that a baby was still in the unit. The engineers were able to rescue the 18 year old who was yelling for help, but the infant was not rescued until later by fire department personnel using portable oxygen equipment. The oxygen support unit of the infant provided an effective area of refuge. Also the closed door to the nursery and the fire resistive room construction prevented untenable heat conditions from developing before rescue.

The activation of the local alarm box in this incident led, according to plan, to a "page 100" announcement over the public address system, with the location of the emergency being given. Personnel initially appeared to interpret the verbal fire alarm public address system announcement as a routine announcement, not requiring patient

evacuation preparation, due to the conditioning effect of numerous announcements in the facility. (Three previous "page 100" announcements had been given in the Center on April 21, 1979, one less than 20 minutes prior to the incident.) Evacuation seems to have been initiated more as a result of receiving verbal information from other staff members as to the extent of the fire, or of becoming aware of the fire through the odor of smoke or arrival of the fire department, than as a result of the public address announcement.

Index Words: Alarms; area of refuge; communications; evacuation; fire incident study; hospital; Lerup mapping technique.

24. Bryan, J.L. and DiNenno, P.J. An Examination and Analysis of the Dynamics of the Human Behavior in the Fire Incident at St. Joseph's Hospital, Philadelphia, Pa. on August 10, 1977. University of Maryland. National Bureau of Standards Report No. NBS-GCR-78-140. May 1978. Final Report. NTIS Order No. PB-287935.

This analysis of the serious fire incident which occurred at St. Joseph's Hospital, Philadelphia, Pennsylvania on August 10, 1977 uses the Lerup mapping technique. Staff performed well and loss of life was small (two fatalities) in the context of a fire already at post flashover development at the time of detection and in an old building with a low fire safety evaluation as determined by NBS/HEW procedure.

The fire which originated in a bathroom was detected first by a nurse's aide who, without supervisory guidance, initiated the evacuation of the immediately threatened patients from the fire zone. The seven nursing staff assigned to the area of fire origin evacuated 34 patients in a period of six to seven minutes. The two patients who remained in the fire zone at the time of fire department arrival were removed by firefighters. Both died. With excellent cooperation between hospital staff and fire and police department personnel, total evacuation of the hospital's 171 patients was accomplished in approximately 16 to 19 minutes. There was much helpful involvement of neighborhood citizens in the patient relocation process.

The tendency to call the fire department even when it has already been notified, a recurrent behavior identified by Lerup, Greenwood, and Burke, did not occur. This was probably due to the training of the staff, which prohibited use of the phone, and their knowledge of the automatic transmission of the manual fire alarm to the fire department, with the telephone operator calling the fire department to confirm its reception.

Index Words: Evacuation; fire incident study; fire fatalities; Lerup mapping technique; hospital; training and education.

25. Bryan, J.L. and DiNenno, P.J. An Examination and Analysis of the Dynamics of the Human Behavior in the Fire Incident at the University Nursing Home on April 13, 1979. University of Maryland. National Bureau of Standards Report No. NBS-GCR-80-191. January 1980. NTIS Order No. PB 80-158157.

Described and analyzed are the human behavior and fire development in the serious fire incident which occurred on April 13, 1979 in Silver Spring, Maryland at the University Nursing Home, a two-story building of protected, noncombustible construction.

The staff was alerted to an already "fully developed fire" in a patient room by the activation of a smoke detector which automatically activated the local alarm system. The detector was located in a lounge approximately 15 feet from the door to the room. Flashover probably occurred approximately two minutes after the activation of the smoke detector while the nursing staff were closing patient room doors. Due to heavy smoke and heat, staff were unable to close the door to the fire room, although they were able to close all the other patient room doors in the involved wing.

In all, 47 patients were evacuated by various means (wheelchairs, blanket carry, arm carry, beds), with the initial evacuation being by fire department ladder due to the extremely heavy smoke conditions in the corridor. Seventeen patients and eight staff were transported to the hospital for medical treatment. Two of these patients subsequently died; one, on April 16 of a heart condition and the other, on April 24 of complications from smoke inhalation. Both of these patients were located on the same corridor as the room of fire origin; the one, in the room just across from it.

The critical initial staff action of closing patient room doors resulted in the reduction of patient casualties. The staff performed well in the face of a rapidly deteriorating environment.

See also reference: Bryan, J.L. and DiNenno, P.J. Human Behavior...

Index Words: Alarms; evacuation; fire fatalities; fire incident study; Lerup mapping technique; nursing home; smoke detectors.

26. Bryan, J.L. and DiNenno, P.J. Human Behavior in a Nursing Home Fire. Fire Journal, Vol. 74, No. 3, 44-47, 141-142, May 1980.

The fire which occurred at the University Nursing Home in Silver Spring, Maryland, on April 13, 1979 is described and analyzed. This article contains an extensive summary of the information in the National Bureau of Standards Report No. NBS-GCR-80-191. See reference: Bryan, J.L. and DiNenno, P.J. An Examination and ... University Nursing Home...

27. Bryan, J.L., DiNenno, P.J. and Milke, J.A. The Determination of Behavior Response Patterns in Fire Situations, Project People II. Final Report - Incident Reports August, 1977 to June, 1980. University of Maryland. August 1980. National Bureau of Standards Report No. NBS-GCR-80-297. NTIS Order No. PB-81-224545. 234 pp.

The results of a research project funded by the U.S. Department of Health and Human Services entitled, "The Determination of Behavior Response Patterns in Fire Situations, Project People II" are summarized and given preliminary analysis in this report. The objective of the study was to relate behavior in fire in an institutional setting to such factors as previous training, exhibited stress, the fire protection features of the structure, and the nature of the fire emergency.

Sixty-five incidents which occurred between August 10, 1977 and June 25, 1980 were studied. The facilities involved were primarily health care facilities. The sample included 25 nursing home or convalescent home incidents and 33 hospital incidents. In addition, two schools, two high-rise apartments, two university dormitories, and one correctional institution were included. The facilities were located in the State of Maryland with the exception of one fire incident in Philadelphia, Pennsylvania and three in Washington, D.C. With some exceptions, these are incidents which were handled successfully by the building occupants with no serious injuries or fatalities. The study procedure utilized both an open-ended, individual interview technique (with one project member interviewing one occupant in a private situation) and a structured questionnaire.

The report contains: a table describing the basic construction of the facility and the fire resistant nature of various features of the fire zone for each incident; a table summarizing staff and fire department actions with the number of persons evacuated, the means of evacuation, the extinguishment behavior, the closing of doors, and the ventilation of smoke through windows shown for each incident; and a table showing specific fire protection features of each facility (sprinklers, alarm systems, etc.).

Each fire incident is also covered separately. Presented are: abstracts from the individual reports on each of the incidents, diagrams illustrating the development of the fire and the movements and actions of the participants, and conclusions derived from the incident studies.

Index Words: Alarms; evacuation; fire extinguishers; fire incident statistics; fire incident study; high-rise buildings; hospitals; Lerup mapping technique; nursing homes; schools, smoke detectors; sprinklers.

28. Bryan, J.L., Milke, J.A. and DiNenno, P.J. An Examination and Analysis of the Dynamics of the Human Behavior in the Fire Incident at the Roosevelt Hotel on April 24, 1979. University of Maryland. National Bureau of Standards Report No. NBS-GCR-80-253. October 1979. Issued July 1980. NTIS Order No. PB 80-220429.

On April 24, 1979 a fire occurred on the eighth floor of the Roosevelt Hotel for senior citizens in Washington, D.C. The fire originated in a top floor bedroom, room 818, apparently on the bed. The fully-developed room fire produced extensive quantities of smoke which spread through all of the eighth floor corridors and into some eighth floor rooms despite the closed door to the room of fire origin. The fire was initially detected by an eighth floor resident who smelled smoke and reported it to the hotel receptionist.

For the most part, evacuation of the eighth floor residents was accomplished on a one-to-one basis by fire fighters, after they had extinguished the fire in room 818. In some cases, the fire fighters placed their face masks from self-contained breathing apparatus on residents due to the heavy smoke. Residents had been told to remain in their rooms in this incident and previous situations, and thus had utilized their rooms as areas of refuge until a fire fighter came to evacuate them.

There was one fatality--the sole occupant of room 818; four other residents received medical treatment at hospitals.

Index Words: Area of refuge; evacuation; fire fatality; fire incident study; high-rise building; Lerup mapping technique; residential occupancy.

29. Bryan, J.L., Milke, J.A. and DiNenno, P.J. An Examination and Analysis of the Dynamics of the Human Behavior in the Fire Incident at the Taylor House on April 11, 1979. University of Maryland. National Bureau of Standards Report No. NBS-GCR-80-200. October 1979. Issued April 1980. NTIS Order No. PB 80-179054.

A fatal fire occurred on April 11, 1979, on Lamont Street in Washington, D.C., in a community residence for psychiatric outpatients called the Taylor House. There were a total of 21 residents and two staff members in the part of the duplex unit directly involved in the fire. A total of ten resident fatalities resulted from this fire which originated in a sofa on the first floor lounge (probably from smoking materials). The facility would not have met the requirements of the National Fire Protection Association Life Safety Code for health care occupancies or hotel occupancies (under which it would be classified due to the number of occupants).

Many factors contributed to the disastrous outcome. The resident detecting the fire, before contacting a staff member in residence,

lost time by attempting to extinguish the fire by pouring water from a coffee jar onto it four different times. The activation of the local alarm system by the maintenance man only activated the bells throughout the 1717 duplex unit and not in the unit of fire origin. Also, the portable fire extinguisher failed to operate for the maintenance man attempting to use it. The combustibility of the first floor lounge area furniture permitted the fire to rapidly propagate within the lounge area. The open interior stairway with combustible finish resulted in the rapid spread of fire and smoke to the second and third floors. There was no second means of egress. Residents were forced to evacuate through windows down fire department ladders. Two residents jumped, with one receiving fatal injuries.

Adaptive behaviors were demonstrated by some residents. A resident from the duplex unit not directly involved in the fire proceeded to the unit of fire origin to assist a blind resident on that floor to evacuate. Three residents evacuated to roofs and awaited fire department rescue. Three other residents waited for the placement of fire department ladders at the windows of their rooms.

See reference: Bell, J.R. Halfway House Fire...

Index Words: Alarms; boarding home; codes and standards; evacuation; fire extinguishers; fire fatalities; fire incident study; handicapped; Lerup mapping technique.

30. Bryan, J.L., Milke, J.A. and DiNenno, P.J. An Examination and Analysis of the Dynamics of the Human Behavior in the Fire Incident at Thurston Hall on April 19, 1979. University of Maryland. National Bureau of Standards Report No. NBS-GCR-80-193. July 1979. Issued February 1980. NTIS Order No. PB 80 163017.

On April 19, 1979, a fire occurred on the fifth floor of Thurston Hall Dormitory, George Washington University, Washington, D.C. During the fire, two students jumped from fifth floor windows and received serious injuries while about 37 occupants in all required emergency medical treatment. Of the 812 questionnaires mailed to students to gather data for this study of the fire, 402 were returned. Individual interviews were also conducted.

The fire was initially detected by five students independently of each other who, upon hearing unusual noises, opened the doors of their rooms to investigate and discovered the fire in the corridor. One of these left the room door open and the fire spread into this room. Besides this one room, the furthest extent of the fire was about 3/4 of the way down one corridor and about 1/2 of the way down the adjoining corridor. Smoke conditions became heavy through-

out the fifth floor, and there was also extensive smoke spread in the floors above the fire floor. The method of evacuation of the fifth floor fire zone depended largely upon proximity to the fire. Occupants confronted by heavy smoke and heat generally waited for fire department assistance. In the case of the two occupants who fell or jumped from fifth floor windows, both had experienced unsuccessful evacuation attempts, receiving burns in the process.

In general, occupants of the dormitory tended to interpret the local fire alarm system abbreviated activation as a false alarm, not requiring evacuation, due to past experience with numerous false alarms in the facility. They tended to evacuate upon receiving reinforcing cues of smoke or smoke odor.

Index Words: Alarms; evacuation; fire incident study; Lerup mapping technique; schools.

31. Buchbinder, L.B. Human Activity Patterns and Injury Severity in Fire Incidents Involving Apparel. Journal of Fire and Flammability/Consumer Product Flammability, Vol. 1, 4-18, March 1974.

Fire incidents involving wearing apparel are analyzed, considering the relationships among such factors as type of accident (i.e., involvement of flammable liquids, no involvement of flammable liquids, etc.), activity of the victim preceding the accident, his reactions, age, sex, and severity of burn injury. Data on 1126 cases from the National Bureau of Standards' Flammable Fabrics Accident Case and Testing System (FFACTS) data base (cutoff date - November 1, 1972) were used for the study.

Some of the major findings were: "After age six, activity patterns were strongly related to the victim's sex, with men the primary victims of accidents involving flammable liquids, gases, or high voltage electricity, and women more susceptible to direct flame ignition. The majority of cases studied had burns over less than 20% of the total area of their body. When flammable liquids were involved, there tended to be fewer minor injuries and more moderately serious injuries than in accidents not involving intermediary materials. Age and defensive capability were major factors determining extent of injury, with persons over 65 and those with limited ability suffering more serious injuries than other groups."*

*from author's abstract

Index Words: Fire incident statistics; handicapped.

32. Bukowski, R.W. Tests on the Performance of Automatic Fire Detectors in Health Care Occupancies - A Preliminary Report. National Bureau of Standards Interagency Report No. NBSIR 79-1739. April 1979. Preliminary Report. NTIS Order No. PB-297150.

This preliminary report gives the results of the first series of eight full-scale fire tests to evaluate the response of automatic fire detectors in health care occupancies to flaming ignition mattress fires. Comparisons were made between three types of detectors (ionization, photoelectric, and heat) installed in the patient room versus in the corridors. The times available for escape or rescue provided by each method of detection were determined by the time provided between detector alarm and the time that one of several criteria selected for occupant tenability was exceeded. (Limits imposed by carbon monoxide, heat, or smoke factors were used as criteria.)

For the fire scenario selected (flaming ignition of bedding and mattress), the results indicated that the ionization-type detectors in the patient room provided the maximum time for escape. The maximum time period available for either rescue of a non-ambulatory patient in the room of origin or for use of the corridor past the room of origin as a means of escape averaged only about five minutes. This relatively short time available for rescue suggests "the need to use other approaches to increase the amount of time available for escape and rescue or to better manage the time available through preplanning and training." The author proposes connecting the detectors in the patient room to the nurse call system in addition to the fire alarm system as a method of better directing the rescue efforts of the staff to make optimum use of the time available.*

*The annotation is based on the author's abstract, with some additional information from the report inserted.

Index Words: Experimental study; hospitals; nursing homes; smoke detectors.

33. Burgun, J.A. The Right to Risk - Normalization. In: Second International Seminar on Human Behavior in Fire Emergencies, October 29 - November 1, 1978 -- Proceedings of Seminar, pp. 45-48. National Bureau of Standards Report No. NBSIR 80-2070. Issued June 1980. NTIS Order No. PB 80-204738.

The contemporary trend toward normalization of the lives of handicapped people has important implications for maintaining an adequate level of fire safety for individuals in all types of occupancies. As entry to various buildings for handicapped persons becomes possible due to the removal of physical barriers, the question arises as to whether these persons could exit these same buildings rapidly enough in case of an emergency, or alternately remain in these buildings in protected areas of refuge.

This paper presents the philosophical basis for the trend toward integrating the handicapped into all aspects of society as fully as possible. The author believes that the handicapped should be allowed to take the kinds of risk we all accept as part of normal life, since if all elements of risk are denied handicapped persons, then essential developmental opportunities are also denied. He also contends that the handicapped should not have to endure more or increased risks than those who are not disabled, and that some special provisions will therefore have to be made for the handicapped. To this end, as Chairman of the Committee on Safety to Life, he appointed a sub-committee to prepare special provisions for the handicapped to be placed in all occupancies sections of the 1980 Life Safety Code, NFPA-101.

The author maintains that extremely costly alterations will not be achieved because of the economic impact on the community. Proposed measures must be evaluated to determine whether they are absolutely essential, cost-effective and not overly restrictive.

Index Words: Codes and standards; handicapped; risk.

34. Burns, R. 10 Die in N.J. Rest Home Fire. Fire Engineering, Vol. 126, No. 4, 58-59, April 1973.

Ten out of sixteen residents of the Street's Rest Home in Pleasantville, N.J. died in a fire on January 20, 1973. The Home had a heat detection system which was designed to directly transmit an alarm to fire department headquarters but which failed to do so in this case. The rest home also had an interior fire alarm system. When the alarm bells sounded in the home, no one phoned in an alarm because they thought the alarm was also sounding at the fire department. This allowed the fire to roar out of control before the fire department was notified by a policeman passing nearby. This fire incident is graphically described and analyzed in the reference: Lerup, L., Greenwood, D. and Burke, J.S...NBS-GCR-76-73.

Index Words: Alarms; fire fatalities; fire incident study; nursing home.

35. Canter, D. Fires and Human Behaviour: Emerging Issues. In: Second International Seminar on Human Behavior in Fire Emergencies, October 29 - November 1, 1978 -- Proceedings of Seminar, pp. 49-64. National Bureau of Standards Report No. NBSIR 80-2070. Issued June 1980. NTIS Order No. PB 80-204738.

Major topics and issues where research is needed in the area of human behavior and fire emergencies are discussed. These are

organized within the framework of a five stage sequential model of human behavior and fires. The stages are: preparation before a fire begins, recognition of a fire once it occurs, actions during the fire, escape, and the aftereffects of the fire experience. Issues specific to fire safety may be related to general concerns in social psychology; e.g., the way in which an individual interprets fire cues such as alarms and gathers further information in order to determine a course of action is relevant to the general area of social-psychological studies of the definition of situations.

Some studies conducted by the Fire Research Unit at the University of Surrey under the author's direction are described. These include a statistical analysis of the effects of a firemen's strike, a study of emergency calls, and a content analysis of media reporting of fires. There were found to be fewer reported fires during the period of a firemen's strike than would ordinarily have been expected; this suggests the importance of social control over fire incidents perhaps through the exercise of more care to prevent fires, a decrease in purposely set fires, or successful attempts to cope with fires by residents themselves. The research regarding media representation of fires revealed that newspapers tend to describe fires as either disasters accompanied by "panic" behavior or great heroic rescue ventures. The study of media representation of fires is important because, as important sources of people's information about fires, the media can be expected to influence their preparation for them.

The author concludes that behavioral studies of fires hold the potential for a radical impact on fire prevention and safety.

Index Words: Conceptual model; fire incident statistics; panic.

36. Canter, D. Fires and Human Behaviour--an Introduction. In: Fires and Human Behaviour, edited by David Canter, Chapter 1, pp. 1-12. New York, John Wiley & Sons, 1980. 338 pages.

This introductory chapter for the book, "Fires and Human Behaviour" presents the author's basic philosophy regarding the role of behavioral research in fire safety, provides an overview of the remaining contents of the book, identifies recurrent themes in the researchers' accounts, and suggests directions for future research.

There is a scarcity of systematic knowledge about human behavior in fire. Past emphasis has been upon engineering solutions to fire safety problems; however engineering solutions are not adequate by themselves. There remain the human causes of fires and the human errors which can magnify the damaging effects of fires.

Recurrent themes found in the human behavior in fire research are

identified within four general areas: human causes of fires; early responses to a fire situation; evacuation; and the effects on individuals and society of fires. Some of the themes are:

The early stage of fire recognition is typically characterized by ambiguity. Acceptance of the situation as a serious fire emergency is frequently delayed.

There are a range of human responses to a fire situation which occur in varying combinations and sequences. No general guidance can be given about which sequence is the safest for all circumstances.

The term "panic" is not a helpful one for researchers. There is very little evidence for it actually occurring in fires. In fact, people seem generally to continue to carry out their normal roles.

Some future emphases for human behavior and fire research are outlined. In the past, much thinking about fire prevention has revolved around the notion of balancing costs and benefits; e.g., the reduction of expenditure on insurance through the purchase of hardware which will reduce risks. The basis of such calculations should be broadened to include the broad social consequences of fires; e.g., costs to health services, the social services required by people left homeless, etc. In the area of modelling of behavior in fires, predictive models based on roles of individuals and occupancy types need to be developed. Finally, the way in which this research can best impact on code makers and legislators needs to be studied.

Index Words: Overview--behavior in fire; panic.

37. Canter, D., Editor Fires and Human Behaviour. New York, John Wiley & Sons, 1980. 338 pages.

This book is a compilation of papers by various researchers. The chapters are annotated separately and referenced in this bibliography under the authors' names.

Annotated chapters are by: (in order of presentation in the book) David Canter; Ian Appleton; Robert G. Vreeland and Bernard M. Levin; Ditsa Kafry; Jonathan Sime; Peter Wood; Claire Whittington and John Wilson; David Canter, John Breaux, and Jonathan Sime; Gilda Haber; Lars Lerup, David Cronrath and John Liu; Perry Edelman, Elicia Herz and Leonard Bickman; Janet Hall; Jake Pauls and Brian Jones; Jake Pauls; Colin Green; Eric Marchant; Richard Strother and Laura Buchbinder.

For an overview of the book's contents, see reference for chapter 1, Canter, D. Fires and Human Behaviour--An Introduction.

38. Canter, D., Breaux, J. and Sime, J. Domestic, Multiple Occupancy, and Hospital Fires. In: Fires and Human Behaviour, edited by David Canter, Chapter 8, pp. 117-136. New York, John Wiley & Sons, 1980. 338 pages.

This is a report on a project conducted at the University of Surrey, England, to study and model behavior patterns of people involved in fires.

A group of domestic, multiple occupancy, and hospital fire incidents was studied to determine the existence, the frequency, and sequence of the full range of actions of the participants in the fire situations. Using an interview technique, the researchers obtained the accounts of 41 people involved in 14 domestic fires, 96 people in 8 multiple occupancy fires, and 61 people in 6 hospital fires. The actions of participants and their sequences were analyzed using a transition matrix. A separate diagram summarizing the decomposition of the matrix is presented for each of the following: all cases - domestic fires, males - domestic fires, females - domestic fires, all cases - multiple occupancies, and all cases - hospitals. These diagrams show the complex sequences of actions which may take place in fires. Numbers on the diagrams linking any two acts give a measure of the strength of association of any two acts; i.e., the more likely that given the occurrence of one act, the one specified will follow it. The fire situation becomes increasingly complex as one moves from domestic, to multiple occupancy, to hospital fire situations; and this is reflected in the increasingly elaborate models needed to describe the behavior in those settings.

A summary general model of behavior was also developed, and is presented as a flow chart. It is evident from this chart that a number of acts recur at different stages in the sequence. The authors maintain that the survival implications of these acts can be determined only in relation to the position in the sequence at which they occur. Studies which only consider the percentage of occurrence of particular acts without relating the acts to a time sequence are ambiguous and perhaps misleading.

Finally, the general model is simplified into a three-part model consisting of interpretation, preparation, and action stages. The individual must choose between options as he moves from one stage to the next. There is a discussion of the building and behavioral factors which influence this selection of options.

Index Words: Conceptual model; fire incident study; hospitals; panic; residential occupancies.

39. Carmack, B.J. Human Behavior in Fires. Journal of Fire and Flammability, Vol. 7, 559-565, October 1976.

The content of this article was based both on a review of the literature and interviews with firefighters. The author was Assistant Professor, School of Nursing, University of San Francisco.

There is a discussion of the phenomenon of panic. The difference in viewpoints between the firefighters interviewed, who felt panic was a frequent occurrence, and disaster researchers, who have concluded the opposite, is described. Perhaps some of the disagreement between these two groups can be accounted for by semantic differences in the use of the word "panic." Considered specifically are the behaviors of jumping from a burning building and reentry of it, and the influence of familial ties on behavior in fire emergencies. The major reasons for failure of people to escape from a fire are explored.

Index Words: Literature review; panic.

40. Chandessaïs, C. Panic-Flight-Evacuation. In: Second International Seminar on Human Behavior in Fire Emergencies, October 29 - November 1, 1978 -- Proceedings of Seminar, pp. 65-90. National Bureau of Standards Report No. NBSIR 80-2070. Issued June 1980. NTIS Order No. PB 80-204738.

This paper uses 17 detailed diagrams to present the results of numerous French studies on the phenomenon of panic. It defines, analyzes and relates the components of panic; explores the mechanism of "contagion" in panic; considers the concept of individual predisposition for the inadapative behaviors of panic; and presents observations on evacuations.*

*Annotation is based on author's abstract with additions.

Index Words: Conceptual model; evacuation; panic.

41. Collins, B.L. and Pierman, B.C. Evaluation of Safety Symbols. National Bureau of Standards Report No. NBSIR 79-1760. June 1979. NTIS Order No. PB-298175.

The increasing use of nonverbal symbols or pictograms to convey fire safety or other essential information is discussed. Research data indicates that symbols can convey information accurately and rapidly, and that, in some cases, they can be more effective than words in communicating a small amount of information. They can, of course, give the same message to people who speak different languages.

There are, however, some difficulties connected with the development

and use of symbols. Symbols are developed by a variety of groups, and this can lead to several different symbols being used in different settings to convey the same meaning. In addition to this standardization problem, there is the even more critical problem of the understandability of a given symbol. Symbols may not be understood or even given a meaning opposite to what was intended. This was the case for a fire-safety symbol, proposed by an International Standards Organization (ISO) committee, which is intended to mean "no exit" but was interpreted as meaning "safe refuge" by some subjects in a validation study described in this report. This study was designed to evaluate the effectiveness of 22 fire safety symbols being considered as a draft international standard by the ISO TC 21 subcommittee on Fire Safety Symbols. Each of these symbols is presented along with the percentage of subjects in the study who identified the correct meaning of the symbol. There was great variability in correct response for the various symbols (from 1% to 95% correct).

Index Words: Codes and standards; communications.

42. Collins, B.L. and Pierman, B.C. Evaluation of Safety Symbols. In: Second International Seminar on Human Behavior in Fire Emergencies, October 29 - November 1, 1978 -- Proceedings of Seminar, pp. 91-114. National Bureau of Standards Report No. NBSIR 80-2070. Issued June 1980. NTIS Order No. PB 80-204738.

See reference: Collins, B.L. and Pierman, B.C. Evaluation of Safety Symbols...NBSIR 79-1760.

Index Words: Codes and standards; communications.

43. Crossman, E.R.F.W., Harari, O. and Zachary, W.B. Cost-Effective Techniques for Improving Return-Rate in Fire-Oriented Mail Surveys. Report No. UCB FRG WP 76-13. University of California at Berkeley. September 1976.

The Human Factors Subgroup of the Berkeley Fire Research Group developed a survey methodology termed FIRRST (Fire Incident, Risk, and Readiness Survey Technique). This methodology used a one-page questionnaire seeking information on such matters as fire and heat-using activities and actually experienced fire incidents. Since an adequate return-rate is needed to ensure relative freedom from bias in surveys of this type, the problem of adequate return-rate was considered. This report discusses how district level return-rates may be increased without incurring disproportionate cost increases. Results showed that pre-contact and post-contact of respondents, and a small gift are cost-effective measures which can produce a "good" (67% or better) or "fair" (33 to 67%) return-

rate using the FIRSST questionnaire format.

Index Words: Fire incident statistics; residential occupancies.

44. Crossman, E.R.F.W. and Wirth, I. Fire Safety Organization of High-Rise Building Occupancies. Report No. UCB FRG 74-15. University of California, Berkeley. August 1974.

This paper deals with organization for fire safety in high-rise buildings. It reviews some prior studies of intra-building fire safety organization. It presents results from a survey in 1973 of 20 high-rise buildings in central business districts of San Francisco, Oakland, and Berkeley. Data are given on the general characteristics of the buildings, the fire protection equipment present, and the fire safety organization. While in hospitals and single-industry buildings, the level of fire safety effort seemed adequate in relation to the risk as measured by maximum occupancy, it seemed inadequate in the apartment buildings studied, and grossly inadequate in the general offices. Thus the authors recommend increased fire safety effort in general-office and apartment occupancies.

Index Words: Fire emergency planning; high-rise buildings; hospitals; residential occupancies.

45. Crossman, E.R.F.W. and Wirth, I. Fire Safety Organization and Management of High-Rise Buildings: Field Data and Recommendations. Fire Journal, Vol. 69, No. 2, 75-81, March 1975.

This magazine article is based on a University of California at Berkeley report. See reference: Crossman, E.R.F.W. and Wirth, I. Fire Safety Organization...Report No. UCB FRG WP 74-9...

46. Crossman, E.R.F.W. and Wirth, I. Fire Safety Organization and Management of High-Rise Buildings: Field Data and Recommendations. Report No. UCB FRG WP 74-9. University of California, Berkeley. April 1974.

This is a study of fire safety organization in high-rise buildings of different types and occupancies. A survey of 20 high-rise buildings in central business districts throughout the San Francisco Bay Area was conducted. The occupancy types covered were: hospital, industry (newspaper), single organization, hotel, general office (private), and apartment building. Data are presented on: the physical characteristics of the building; fire safety equipment available; dimensions of the fire safety organization (i.e., level of fire safety manager in general building organization, number of levels in fire organization, and number of positions in fire organ-

ization); and manpower allocation to fire safety organization. Hospitals achieved the highest scores on both equipment availability and manpower allocation; apartment buildings consistently scored at the lowest level.

Index Words: Alarms; fire emergency planning; fire extinguishers; high-rise buildings; hospitals; residential occupancies; smoke detectors; sprinklers.

47. Crossman, E.R.F.W. and Zachary, W.B. A Fire Risk and Readiness Study of Berkeley Households, 1974. Fire Journal, Vol. 71, No. 1, 67-74, January 1977.

This magazine article is based on a University of California at Berkeley report. See reference: Crossman, E.R.F.W., Zachary, W.B. and Pigman, W. FIRSST...Report No. UCB FRG/WP 75-5...

48. Crossman, E.R.F.W. and Zachary, W.B. Occupant Response to Domestic Fire Incidents. Minitalk at NFPA Annual Conference - Miami, May 20-24, 1974. Report No. UCB FRG WP 74-8. University of California, Berkeley. May 1974.

There is a need for information from sources other than fire department records on occupant response to fire at the ignition and early development stage. This study explores some data gathering approaches and provides some preliminary results. Described is the uniform-density geographical sampling technique used. This approach was designed to yield as nearly unbiased sampling as could be expected at moderate cost in a given administrative area. 400 questionnaires were randomly distributed in 4 Berkeley Fire Districts (Nov. 1973 and Jan. 1974). One large problem encountered was the poor return rate of the questionnaires from the lower socioeconomic areas. Some interview data was also collected. Some sample results are presented for: hazard (exposure) rates, fire incident frequencies by source, actual extinguishment methods, hypothetical extinguishment choices, and fire preparedness.

Index Words: Fire emergency planning; fire extinguishers; fire incident statistics; residential occupancies.

49. Crossman, E.R.F.W., Zachary, W.B. and Pigman, W. FIRSST; A Fire Risk and Readiness Study of Berkeley Households, 1974. Report No. UCB FRG/WP 75-5. University of California at Berkeley. May 1975.

This report details the methodology used and results obtained from a survey conducted in May 1974 of a geographically random sample of 3,500 households in seven fire districts of Berkeley, California. The information obtained using a one-page questionnaire involved

three main areas: presence of fire hazards, preparedness (availability of fire protection equipment and fire knowledge of respondents), and opinions regarding fire safety policy.

Some conclusions were: This type of survey is necessary to obtain complete data since many household fire incidents do not come to the attention of the fire department; in this sample, household members relied largely on their own efforts for fire protection; and a major focus of fire safety activity should be the provision of information and education related to fire suppression technique.

See also reference: Crossman, E.R.F.W. and Zachary, W.B. A Fire Risk...Fire Journal...

Index Words: Fire emergency planning; fire extinguishers; fire incident statistics; residential occupancies; smoke detectors; training and education.

- 49a. Demers, D.P. 25 Die in Nursing Home. Fire Journal, Vol. 75, No. 1, 30-35, January 1981.

A fire occurred on July 14, 1980 in the Extendicare Skilled Nursing Facility in Mississauga, Ontario, which resulted in 25 patient deaths. The facility had complied with Province of Ontario fire regulations.

The fire originated in a patient room, probably through misuse of smoking materials. The first notification of the fire was by activation of the fire alarm system, most likely by the heat detector in the room of origin. A nurse was unable to enter this room because of the fire, but knew a patient was still in there. She closed the room door and reportedly went to get wet sheets and blankets to attempt to remove the patient. A supervisor returned to the room, reopened the door, but was unable to close it again due to the fire. The 25 fatalities consisted of the entire patient population of the wing of fire origin. Eight of these victims were in rooms on which the doors had been closed. A great deal of difficulty was encountered in evacuating other occupants of the fire floor. Problems were encountered due to rescuers moving stretchers and wheelchairs down the stairs, while firefighters and other rescue personnel were going up the stairs.

This article uses the 1976 edition of NFPA 101, the Life Safety Code, for purposes of analysis. One variation from the Code's requirements for existing health care facilities was the lack of automatic fire alarm transmission to the Mississauga Fire Department.

The most significant factors that contributed to the multiple fatalities were: rapid fire development, failure to extinguish

the fire in its incipient stage, failure to keep the door of the room of origin closed, improper actions of the staff, and delayed alarm to the fire department.

Index Words: Alarms; codes and standards; evacuation; fire fatalities; fire incident study; nursing home.

50. Design and Construction of Building Exits. NBS Miscellaneous Publication M151. October 1935.

This is an early study of building exit capacities conducted by the National Bureau of Standards which had a great impact on the Life Safety Code. A survey was made of existing exit design practice in buildings. People movement through exits was also surveyed. Measurements were taken of the number of people that traversed various exit components and the time during which the components were traversed. Methods of calculating necessary exit widths were discussed. The study resulted in establishing capacities for stairs, doorways, corridors, ramps, and escalators.

Index Words: Codes and standards; evacuation.

51. Edelman, P., Herz, E., and Bickman, L. A Model of Behaviour in Fires Applied to a Nursing Home Fire. In: Fires and Human Behaviour, edited by David Canter, Chapter 11, pp. 181-203. New York, John Wiley & Sons, 1980. 338 pages.

The authors present a general model of human response to fire and apply it to the actions of staff and residents in a nursing home fire which resulted in two fatalities. Twenty-two residents from the nursing home were interviewed approximately two to four weeks after the fire occurred. Most had been in good condition in terms of mobility. Using a flow chart arrangement, the data obtained was applied to the three stages of the model: detection of initial cues, definition of the situation, and coping behaviors. Lastly, the factors which may influence the types of behaviors exhibited in the three stages are considered. These "determinants of behavior" may be physiological/ physical, intrapersonal (past experiences), educational/preparatory, or social in nature. In addition, they may be characteristics of the fire or the physical environment in general.

The sounding of the alarm by itself was found not to convince respondents of the existence of a fire and the need to escape. Other cues, such as indications from others or perceiving smoke or flames, were needed to motivate escape behavior. The lack of response to the alarm was probably a result of frequent false alarms in the past.

One of the most significant findings of the study was the failure to use the emergency stairs at the end of the hallway. There was

no indication that any exit aside from the center stairway was used by any resident of the fire floor (except those few who used the elevators or were assisted by firefighters). As many as 85 residents were evacuated down one of four possible stairways. Use of the center stairway meant most residents were moving toward the fire. Failure to use the most appropriate means of escape stemmed from several factors: lack of practice using emergency exits, lack of proper instruction and example by staff during the fire, and negative associations with the use of emergency exits coupled with signs on the emergency doors which strengthened these negative associations. An alarm had been set off often in the past by residents who had attempted to leave through these exits, and some respondents mentioned that residents who were caught using these exit doors were scolded.

Index Words: Alarms; conceptual model; evacuation; fire fatalities; fire incident study; nursing homes; training and education.

52. Finucane, M. and Marchant, E.W. Hospital Fire Safety, Non-Attendance and Patient Mobility. In: Second International Seminar on Human Behavior in Fire Emergencies, October 29- November 1, 1978 -- Proceedings of Seminar, pp. 115-144. National Bureau of Standards Report No. NBSIR 80-2070. Issued June 1980. NTIS Order No. PB 80-204738.

This paper focusses on two staff-related aspects of the hospital fire safety problem: (1) the amount of time that a patient-occupied space may be unattended by staff, and (2) the staff help needed by various types of patients to make a successful evacuation in the event of fire. The data for the studies was obtained from some preliminary observations carried out in some hospitals around Edinburgh, Scotland.

Non-attendance times for one type of ward (post-natal) are presented. In all the activity spaces in this postnatal ward, periods of non-attendance exceeding five minutes were observed. Spaces associated with, or adjacent to, patient spaces, from which a fire could threaten patient-occupied spaces directly, were found to be unstaffed for periods up to 72 hours. The additional risk of a fire not being detected in its initial stages resulting from these periods of nonattendance needs to be taken into consideration in fire safety planning.

A second part of the study dealt with the problems of preparing patients for evacuation and moving them to a place of safety. A concept called the Patient Mobility Factor is introduced as a mean of identifying the difficulty of evacuating a particular type of ward and of comparing it to other types of wards. It is a ratio of the total number of staff actions required (both to prepare for and

maintain evacuation) to the number of patients in the ward. In some wards, the number of staff that would be required for simultaneous evacuation could not be made available, and timely evacuation of all patients is not feasible. Emphasis in these cases would be better placed on other measures such as surveillance (automatic or manual) to discover an ignition early and effective fire suppression techniques (automatic or manual).

Index Words: Evacuation; fire emergency planning; hospitals; smoke detectors.

53. Francis, R.L. and Saunders, P.B. EVACNET: Prototype Network Optimization Models for Building Evacuation. National Bureau of Standards Report No. NBSIR 79-1738. October 1979. NTIS Order No. PB 80 113780.

The evacuation of buildings is analyzed by means of computerized network flow optimization models. Such an evacuation model was constructed for an eleven floor building which is part of the National Bureau of Standards complex in Gaithersburg, Maryland. A "skeletal" network model of the building was constructed which represents the following entities (as well as paths of movement between them): workplaces, halls, doors between workplaces and halls, stairwells, doors between halls and stairwells, doors between stairwells and the lobby, and lobby doors. The model determines by itself an evacuation routing of the people in the building so as to minimize the time to evacuate the building. The model depicts the evacuation of the building as it changes over time: time is divided into discrete time periods, and the model indicates the changes in the evacuation status during each time period, as well as the evacuation status at the end of each time period. Data for the model include such things as the numbers of people in workplaces prior to evacuation, stairwell flow-rate capacities, hall and lobby flow-rate capacities, as well as static capacities such as the total number of people a hall, workplace, or stairwell can accommodate. By making repeated computer runs of the model with different data sets, such questions can be addressed as: What if we could use "express elevators" to facilitate evacuating the building? What if a fire blocks a stairwell and/or some halls? Etc.

This computer model has some clear advantages over such other approaches as the use of graphical models, pictorial representations of building evacuation, and actual trial building evacuations. The computer model is often quicker, cheaper, can handle larger problems, and greatly facilitates the comparison of many alternatives.*

*Annotation is excerpted from author's extended abstract.

Index Words: Computer model; egress model; high-rise building.

54. Galbreath, M. Time of Evacuation by Stairs in High Buildings. Building Research Note 8. Division of Building Research, National Research Council of Canada, Ottawa. 1969.

Evacuation times for multi-story buildings are predicted taking into account such variables as number of floors, number of occupants per floor, and area of exit stairs.

Some early U.S. and British evacuation studies are summarized. Data regarding the relationship between concentration of people on stairs and speed of forward movement and resultant discharge from stairs are presented. A formula for calculating the time for complete evacuation of a building by stairs is given which uses these variables: number of people above the first floor; number of people who can stand on the stairs at 3 sq. ft./person or the number of people on the floor, whichever is less; the rate of discharge of the stairs in people per unit exit width per minute; and the number of units of exit width in the stair (i.e., the number of 22-inch increments).

The results of a survey of 10 office buildings (1968) are given. The data show evacuation times in practice drills relative to building height, area of stairs, and number of occupants per floor at the time of the survey. These evacuation times are compared to those calculated by the formula. The calculated times were on the average less than the drill times by about two minutes. The greater differences were associated with buildings having long corridor systems and those with low population density.

Evacuation times for various building heights and occupant densities are calculated. The maximum number of occupants per floor (one 44-inch stair) which can be evacuated in 10, 7 1/2, and 5 minutes in buildings from 3 to 20 stories in height are shown. Also, given in another table, are evacuation times for buildings of 15 - 50 stories (based on one 44-inch stair) for densities of 240, 120, and 60 persons per floor. Many of these times are impractically long.

Index Words: Egress model; evacuation; fire drills; high-rise buildings.

55. Glass, R.A. and Rubin, A.I. Emergency Communications in High-Rise Buildings. In: Human Response to Tall Buildings. Conway, J.J., Editor. Ch. 22, pp. 293-301. Stroudsburg, PA, Dowden, Hutchinson & Ross, Inc., 1977.

This chapter presents a brief history of the development of high-rise buildings and discusses the problem of communications in a fire situation in modern high-rise buildings. Total evacuation is impractical and areas of refuge must be provided. No single approach to fire safety is adequate. The authors emphasize the need for a

control center rather than a simple communications network in this complex situation. Described are some physical design problems with present communications systems. Also detailed are psychological problems such as possible ambiguity of voice communications and anxiety of those occupants who are aware of a fire situation but not on floors designated for evacuation.

Index Words: Area of refuge; communications; evacuation; high-rise buildings.

56. Glass, R.A. and Rubin, A.I. Fire Safety for High-Rise Buildings: The Role of Communications. National Bureau of Standards Building Science Series 115. April 1979. GPO: Stock No. 003-003-02016-8.

This literature survey reviews the communication requirements for fire safety in high-rise buildings. The various factors which contribute to the complexity of the fire safety problem in these buildings are explored--for example, the great variety of occupant characteristics and building types and the fact that total building evacuation in high-rise structures is not considered feasible. A voice communications system with a control center is needed in addition to a general alarm if partial evacuations are to be substituted for total evacuation. The various options in a voice communications system are described: one-way or two-way communication, the proper mix of live and recorded messages, content of the messages, and the staffing of the control center. References are made to the voice communications system in the Seattle Federal Building.

It is emphasized that any communications designed for fire safety must be in accord with a total "systems approach" to be optimally effective. Design requirements for visual and auditory warning devices are discussed as well as the physical design problems relating to equipment malfunctions and the passage of communication cables through parts of a building on fire.

Three studies of fire safety are detailed: the fire in the World Trade Center in New York in 1975 in which people would not behave according to the communications system plan, Jake Pauls' observations of a fire drill involving the use of a voice communications system in a rather complex movement of people, and a study by John Bryan with relevance for the problem of visual communications.

Portions of several model codes which cover communications systems are presented.

Index Words: Codes and standards; communications; fire drills; fire incident study; high-rise buildings; literature survey.

57. Globerson, S. and Andrade, R. Simulation of Fire Incidents with Emphasis on Human Behavior. Report No. UCB FRG WP 74-7. University of California, Berkeley. August 1973.

This paper describes a system-level computer simulation model of fire ignition, propagation and control. The objectives in building the model were: to acquire more familiarity with variables which may influence the outcome of a fire incident, to make a preliminary sensitivity analysis which would help discriminate between the less and the more important variables, and to use it as an experimental tool for predicting the results of different fire-protection policies. Appendix A contains a Technical Manual for the Fire Simulation Program. Appendix B contains a Users' Manual which describes how to run a fire simulation experiment (without necessarily knowing the details of the computer commands given in Appendix A).

Index Words: Computer model.

58. Globerson, S. and Crossman, E.R.F.W. Behavior Dynamics of Carbon Monoxide and Other Toxic Gases in Relation to Fire Safety. Report No. UCB FRG WP 74-14. University of California, Berkeley. August 1973.

There is some evidence victims' unawareness of fire situations is sometimes due to the effect of carbon monoxide. This report contains a mathematical description of the chemistry involved in the body's intake of carbon monoxide. It lists physical symptoms at varying concentrations of carboxyhemoglobin. Even low levels of carboxyhemoglobin (without severe symptoms) may have an influence on the ability to discriminate and respond. Psychological and physiological effects of a combination of two or more toxic gases are not simply additive on one another. The report presents a model showing the dynamics of the interaction between the different gases and the subject involved.

Index Words: Toxic gases, influence of.

59. Globerson, S. and Crossman, E.R.F.W. Berkeley Fire Incident Survey Initial Results. Report No. UCB FRG WP 74-2. University of California, Berkeley. August 1971.

Five hundred forms were distributed to randomly selected staff members of the University of California, Berkeley, in August 1971. One hundred fifty-three forms were returned; of these, forty-two reported a fire incident. Data are presented on time of incidents, locations, firefighting methods used, and notification of the fire department. Approximately 60% of the total fire incidents reported were in the kitchen (much higher than the 15% or so encountered in normal fire accident statistics). Only 21% of the fire incidents were reported to the fire department.

Index Words: Fire incident statistics; residential occupancies.

60. Globerson, S. and Crossman, E.R.F.W. Human Factors in Fire Safety: Literature Survey and Preliminary Analysis. Report No. UCB FRG WP 74-3. University of California, Berkeley. June 1972.

This report analyzes human behavior factors in fire safety based both on a literature survey and an original point of view. It presents a system analysis of the fire process. One flow chart describes normal activities related to fire (prevention of undesired ignition, detection of undesired ignition, the control process). Another chart presents abnormal activities related to fire (false alarms, arson, panic).

Index Words: Conceptual model; literature review.

61. Globerson, S. and Crossman, E.R.F.W. Statistics on Fire Hazard, USA and UK, 1940-1970. Report No. UCB FRG WP 74-1. University of California, Berkeley. August 1971.

Presented are statistics on fire losses, time of fires, and causes of fires in various occupancies in US and UK. Statistics on human error (i.e., cooking activity) as a cause are too general to be of value. The overall conclusion is that while the available statistics were useful in dimensioning the major human factor problem areas, they would be of relatively little use in formulating scientific models needed for a systematic engineering application to human factors in fire safety.

Index Words: Fire incident statistics.

62. Gosswiller, E. The "Slow Whoop" An Alternative Standard Fire Alarm Signal. Fire Journal, Vol. 69, No. 5, 21-23, 100, September 1975.

Arguments for regarding the "Slow Whoop" sound as the best choice for a standard fire alarm signal are presented. Technically the "Slow Whoop" is a "frequency modulated square wave tone that starts at a base frequency of 500 to 700 Hz and gradually rises approximately one octave (twice base frequency) in 2.5 to 4.0 seconds. Then it cuts off and, after a short pause of 0.3 to 0.5 seconds, it starts again at the base frequency and repeats."

Some of the points in favor of the "Slow Whoop" are: its siren-type tone (universally recognizable as a warning of danger; its tonal complexity, with one-half of its sound energy in the fundamental frequencies, providing a more effective signal than bells or horns, which release a large part of their energy in the high frequency range; and its capacity to be generated by electronic, electromechanical, or pneumatic means. While conventional fire alarm bells or horns have limited acoustic output, the "Slow Whoop" can be generated with any desired amount of power.

Index Word: Alarms.

63. Green, C.H. Risk: Beliefs and Attitudes. In: Fires and Human Behaviour, edited by David Canter, Chapter 15, pp. 277-291. New York, John Wiley & Sons, 1980. 338 pages.

The author's principal interest was in determining what is an acceptable or optimum risk in relation to the fire hazard in buildings. Various experimental studies relevant to this determination are cited, including those conducted by the author and colleagues at the University of Dundee, Scotland. The attitudes involved relate to the "acceptability" of any given level of risk; the relevant beliefs are primarily those concerning people's perception of what level of risk is involved in various situations and activities.

The meaning of the term "risk" and the potential for confusion in its use is explored. It may refer to the probability of an event occurring, or this probability coupled with a consideration of the severity of the event, or it may be used to refer to the feature of the situation which gives rise to the possibility of an accident (i.e., a hazard).

People's attitudes and beliefs about risk are built up by a knowledge of accidents experienced by themselves or others and these attitudes and beliefs have an effect upon such behaviors as "demands for decreased risk" or "response to accidents." Attitudes and beliefs may be revised as new knowledge of accidents is acquired, with behaviors being correspondingly affected. A graphical model is presented to demonstrate these interrelationships.

In order to derive an appropriate "measure" of safety, various quantitative characteristics of the situation may be determined (i.e., chance of an accident, annual risk of death, risk of serious injury). A consideration of acceptable levels of safety also involves such qualitative considerations as whether the activity is voluntary or involuntary, or whether the person at risk can control the probability of an accident. In practice, the use of a concept of an acceptable level of safety as a design criterion would presuppose that some accidents at some frequency will be accepted.

Index Words: Conceptual model; experimental studies; literature review; risk.

64. Green, C.H. and Brown, R. Life Safety: What Is It And How Much Is It Worth? British Research Establishment Current Paper CP 52/78. Fire Research Station, Borehamwood, Great Britain. June 1978.

This report is relevant to the broad question of the level of safety which society regards as necessary to maintain through regulation and design features. Since the amount of resources available for safety are not limitless, knowledge of attitudes

regarding safety are relevant to a determination of where too much or too little safety has been required.

A study was conducted using a variety of questionnaires administered mainly to students (also a small sample of non-students) to determine what factors influence the perceived relative safety of situations and to determine the strength of preferences for different levels of safety in a variety of situations. Individuals were found to be highly consistent over time in their beliefs as to the relative safety of different situations. The perceived safety of an activity or situation was correlated with various factors such as perceived likelihood of an accident occurring and type of activity (voluntary vs. involuntary). To determine strength of preference for safety, i.e., how much someone prefers one level of safety to another, respondents were asked to express how satisfied they would be if the present level of safety in one hazard were that prevailing in some other. It is concluded that there is insufficient evidence as to whether the same level of safety is required in all situations or whether lower levels of safety are accepted in voluntary activities than in involuntary activities.

There is a general discussion of societal attitudes toward safety. Society seems more concerned with multi-fatality accidents than individual accident deaths. Preliminary study points to the explanation that people tend to blame the person killed in a single person accident for getting himself killed due to carelessness, etc., whereas with multiple fatality accidents, it is less credible to blame the victims for their own deaths.

Index Words: Experimental studies; risk.

65. Groner, N.E., Loftus, E.F. and Keating, J.P. Calling Nurse Blaze: Tailoring Programs to Fit Human Behavior. Journal of the American Hospital Association, Vol. 52, No. 14, 111-115, July 16, 1978.

Researchers conducted a study to analyze hospital fire safety procedures and training, with a particular emphasis on verbal alarm systems. Interviews were conducted with the safety specialists of four general hospitals in the Puget Sound area. In three of these hospitals, color coded announcements were used to alert the staff; the other hospital used a simple alarm bell. A broader investigation covered 150 hospitals in the Washington State area. Only three hospitals used undisguised verbal instructions to alert personnel. Combined bell and disguised verbal messages or verbal messages only were commonly used. A remarkable variability in verbal coded messages to alert staff was found, from "code red" to "Smokey the Bear in the west wing."

The alarm systems commonly in use often fail to meet several desired criteria. These include: a standardized alarm for all

medical facilities, an alarm that is disguised from patients and visitors, and an alarm that makes the exact nature and location of emergencies immediately apparent without confusing the staff. The fire alarm message, "Nurse Blaze, (floor and wing designation)" was chosen as satisfying the desired criteria. The surname "Blaze" was arrived at after two types of studies--one, a word association test to determine a name to connote that a fire was in progress and two, a test to determine the plausibility of surnames from the two most fire-associated words from the first study.

A more complete report of this study is found in NBS-GCR-77-102, "Vocal Emergency Alarms in Hospitals and Nursing Facilities: Practice and Potential" as listed in this bibliography under "Keating, J.P..."

Index Words: Alarms; communications; experimental study; hospitals.

66. Haber, G.M. Human Behavior in Fire Depending Upon Types of Occupancy: Health Care, Penal and Leisuretime Occupancies. In: Second International Seminar on Human Behavior in Fire Emergencies, October 29 - November 1, 1978 -- Proceedings of Seminar, pp. 147-158. National Bureau of Standards Report No. NBSIR 80-2070. Issued June 1980. NTIS Order No. PB 80-204738.

This paper postulates that an important factor influencing human behavior patterns in fire emergencies is the type of occupancy in which the fire occurs. Two major categories of institutions, total and non-total, with differing social structures and lines of authority, are described. Expectations for types of behavior for these types of occupancies are given along with information obtained regarding actual fire incidents.

Hospitals, nursing homes and prisons (total institutions) are highly organized, lines of authority are highly structured, and the patients or inmates are highly dependent on the staff; whereas leisuretime occupancies such as night-clubs (non-total institutions) have limited organization, no authoritarian staff, and a changing occupancy often having limited familiarity with the layout of the building. Within the total institution category, penal institutions present special problems since they are designed to prevent escape; prisoners often set fires; fire-fighting equipment is often not readily accessible; etc. In a contrasting occupancy--nightclubs, disastrous fires have resulted from such factors as overcrowding, locked exits, highly flammable furnishings, and delay upon the part of staff and owners in notifying the fire department.

Index Words: Fire incident study; hospitals; nursing homes.

57. Hsber, G.M. Human Behaviour in Fires in Total Institutions. In: Fires and Human Behaviour, edited by David Canter, Chapter 9, pp. 137-154. New York, John Wiley & Sons, 1980. 338 pages.

Detailed accounts of three fires in total institutions are given. Total institutions are defined as those providing 24 hour care for residents or inmates, with staff having considerable or total authority. These cases were selected to illustrate three types of situations: "catastrophe"--a nursing home; "near catastrophe"--a penal institution; and "success"--a home for the retired aged. Design recommendations of the author and changes in fire protection measures made by authorities after the incidents are presented.

The nursing home fire resulted in 21 patient deaths. People in a social hall died largely because the lack of a door on the hall allowed smoke to pour in. Further, the door of the room of fire origin, initially shut, was subsequently opened. In the fire in the penal institution, delays were caused by inadequate communication between female staff and the male officers who were called to cope with the situation. In response to the matron's call for help, initially only two men were sent to the affected area. They brought no fire-fighting equipment and were unfamiliar with the layout of the women's section. Severe conflict was experienced by the matron who wanted to let the prisoners out of the fire area, but was faced with the problem of their possible escape.

Index Words: Fire fatalities; fire incident study; firesetters; nursing home; panic.

68. Hall, J. Patient Evacuation in Hospitals. In: Fires and Human Behaviour, edited by David Canter, Chapter 12, pp. 205-225. New York, John Wiley & Sons, 1980. 338 pages.

Nursing staff in a fire situation are faced with the dilemma of deciding whether to leave patients in an area of presumed safety or to evacuate them to an area of greater safety, incurring some risk to themselves and the patients in the evacuation process. The study described in this chapter assumes that the decision to evacuate has been made, and is aimed at determining from the wide variety of evacuation methods taught those which are most appropriate to use in a given environmental or fire condition. The study analyzed three evacuation exercises conducted at Hackney Hospital in Great Britain in 1975. The effectiveness of the evacuation methods was evaluated using these criteria: speed, minimum physical effort, minimum number of staff, easily learned procedure, safety for patients and staff, and minimum risk of malfunction. Both horizontal (no use of stairs) and vertical evacuations (not appropriate for all methods) were conducted.

Recommendations are made for methods appropriate to three types of fires. In the "Type A situation," there is an immediate threat to patient safety from smoke and fire, and evacuation must be completed as rapidly as possible. The priority is to keep patients and staff

as low as possible; hence, although slower and more strenuous than many methods, the blanket and "pyjama" methods (involve dragging the patient along the floor) are recommended for this situation.

In "Type B" evacuation, where the danger to life is not immediate but speed is still essential, the various lifts or movement by bed or wheelchair are advised. These methods are quick; however, for lifts, the staff must have adequate strength, and for movement by bed or wheelchair, the dimensions of the route must be adequate and the route must be relatively free of obstructions. In the exercises at Hackney, staff spent 2.5 minutes just shifting furniture.

In "Type C" precautionary evacuation, where the fire is in an adjoining building or floor, and there is more time; bed, wheelchair, and lifts are all possible methods, with the wheelchair method being the most suitable provided it is not dangerous to transfer the patient from the bed.

Index Words: Evacuation; experimental study; hospital; training and education.

69. Helzer, S.G. Using Behavioral Data in Fire Safety Analysis. In: Second International Seminar on Human Behavior in Fire Emergencies, October 29 - November 1, 1978 -- Proceedings of Seminar, pp. 159-171. National Bureau of Standards Report No. NBSIR 80-2070. Issued June 1980. NTIS Order No. PB 80-204738.

A method for evaluating alternative approaches to reducing fire losses called decision analysis is described in general, and then illustrated using the example of fire losses due to the ignition of upholstered furniture. The need for more behavioral data is emphasized.

The steps in the decision analysis procedure are to: define the problem; identify alternatives; model for each alternative estimated fire losses under it as well as the cost of implementing the alternative; perform sensitivity analyses, and either come to a decision or decide to gather more data and repeat the analysis.

Losses were modeled for upholstered furniture fires using a probability tree structure. Various elements in the fire scenario, such as types of ignition, the presence or absence of an awake person, and the presence or absence of a functional smoke detector, were used to determine the branches of the probability tree. Probability values were assigned to the various branches of the tree. The primary source for assigning probability values was the best "judgment" of fire research experts; the researchers would have preferred to use direct human behavioral data had it been available.

The fire loss model briefly sketched above was used to calculate predictions of future annual fire losses under each of three alternatives: no action, required installation of smoke detectors in residences,

and a mandatory flammability standard for upholstered furniture. To evaluate alternatives, it was also necessary to consider the "cost" of the various alternatives over time. The "best" alternative can be considered to be the one for which the sum of the cost of its implementation plus fire losses incurred under it has the lowest value. The "cost plus loss" under the proposed flammability standard is initially quite high but becomes quite low in the long run. On the other hand, the "cost plus loss" under the detector alternative is initially lower than under the proposed standard, but in the long run is higher.

Sensitivity analyses were used to determine how outcome values would be affected by changes in assumptions and the values assigned to parameters. For example, if a nominal value of \$300,000 is assigned to represent the amount that society would be willing to pay to prevent a single fire fatality, the standard and detector alternatives are about equally attractive and preferred to no action. However, if a value is assigned in the range between \$60,000 and \$300,000, the detector alternative becomes the most attractive; for values above \$300,000, the proposed standard is most attractive; for values less than \$60,000, no action is preferred.

Index Words: Conceptual model; fire fatalities; fire incident statistics; residential occupancies; risk.

- 69a. Helzer, S.G., Buchbinder, B. and Offensend, F.L. Decision Analysis of Strategies for Reducing Upholstered Furniture Fire Losses. National Bureau of Standards Technical Note 1101. June 1979. GPO Order No. 003-003-02078-8.

This is the complete report of the research described in reference number 69, above.

70. Herz, E., Edelman, P. and Bickman, L. The Impact of Fire Emergency Training on Knowledge of Appropriate Behavior in Fires. Loyola University of Chicago. National Bureau of Standards Report No. NBS-GCR-78-137. January 1978. Final Report. NTIS Order No. PB-285472.

This experimental study was designed to determine the effectiveness of a lecture training session in increasing nursing home staff's knowledge of the home's fire emergency plan. Attitudes toward fire preparedness and general knowledge of appropriate behavior in fire were also assessed.

Staff members from a nursing home in Evanston, Illinois were randomly assigned to "training" and "no-training" groups. Members of the "training" group attended a 50-minute lecture given by a member of the fire department covering the first page of the institution's fire emergency plan. Both groups completed the same 16-page questionnaire.

In general, it was found that nursing home staff members in both groups held positive attitudes toward training for fire emergencies. Significant differences in attitudes were not expected and not found between the two experimental groups, with the exception of the response to one item in this series. Significantly more of the no-training group than of the training group agreed with the statement,

"The thought of my being in a fire is very disturbing." Perhaps staff members in the training group felt more competent to handle a fire emergency as a result of the lecture.

A large proportion of the staff members were unfamiliar with some aspects of the fire emergency plan. This lack of knowledge can be explained by the fact that only 17% of the respondents had ever read the plan, and the fact that the plan was unclear and apparently contradictory in some instances.

The training group was expected to have more knowledge about the first page of the fire emergency plan since it was covered in the training lecture. Analysis of items testing this knowledge gave mixed results, with significant differences between the two groups' performances on some items but not on others. The training group scored significantly better on some items testing simple factual information; e.g., questions of the location of fire extinguishers and the nature of the fire alarm system. However, no significant difference was found between the training and no-training groups with regard to a question on whether to evacuate ambulatory or non-ambulatory patients first. A majority of both groups incorrectly indicated that non-ambulatory patients should be evacuated first. In instances like this, where there are strong erroneous preconceptions regarding appropriate behavior in fire, more thorough training methods, including simple explanations of why such beliefs are in error, are needed.

This was the pilot study for a more extended study which involved six Illinois nursing homes and assessed the impact of training on staff behavior in fire drills as well as on staff knowledge of appropriate behavior. See reference: Bickman, L., Herz, E., Edelman, P. and Rivers, D...NBS-GCR-79-179...

Index Words: Evacuation; experimental study; fire emergency planning; nursing home; training and education.

7Ca. Holton, D. Boarding Homes -- The New "Residential" Fire Problem? Fire Journal, Vol. 75, No. 2, 53-56, March 1981.

The factors contributing to the establishment of residential care facilities for the physically disabled, mentally impaired, and the aged; and the nature and scope of the fire safety problem in such facilities are discussed. These facilities are variously referred to as halfway houses, boarding homes, unlicensed nursing homes, sheltered care homes, etc. They provide room, board, and some personal services to the residents. The level of service is less than in a nursing home.

Beginning with the fire at the Wayside Inn Boarding Home in Farmington, Missouri on April 2, 1979; in all, eight boarding home fires in a year and a half killed a total of 120 elderly and impaired individuals. There are an estimated 300,000 residential care facilities in the U.S.--12 times more than the number of nursing homes. Unless present circumstances change, it can be anticipated that serious further loss of life will occur.

A large number of residential care facility residents have been deinstitutionalized, that is, discharged from state mental hospitals, training schools, and veterans hospitals and placed into these community residences. The factors which have come together to produce the deinstitutionalization movement are described. These are: the unbridled growth of the state mental hospital system and its ultimate decline, the advent of psychoactive medications, the Supreme Court rulings concerning patients' rights, and certain financial incentives to states. A strong inducement for states to support a policy of deinstitutionalization comes from the fact that it is financially advantageous for the state to discharge a person from a state mental hospital, where little of the cost of maintaining the individual is reimbursable from the federal government, and instead place him in a boarding home and on the federal Supplemental Security Income (SSI) rolls.

In return for certain federal matching grants to states, the states must agree to license boarding homes and certify that SSI recipients living in them are in a safe environment in a home in compliance with state law. All states have stated their intention to comply with the law, but there has not been a serious effort at enforcement. State and local laws vary greatly in their stringency. In practically all jurisdictions, the fire codes applied to these structures are improper or inadequate based upon current building occupancy and usage. A comprehensive national model standard, which could be mandated federally and/or adopted locally, needs to be developed as quickly as possible.

The author of this article is the Chief Investigator for the U.S. House of Representatives Select Committee on Aging, chaired by U.S. Representative Claude Pepper.

Index Words: Boarding homes; codes and standards; fire fatalities; handicapped.

71. Horiuchi, S. An Experimental Study on Exit Choice Behavior of Occupant in an Evacuation under Building Fire. In: Second International Seminar on Human Behavior in Fire Emergencies, October 29 - November 1, 1978 -- Proceedings of Seminar, pp. 173-185. National Bureau of Standards Report No. NBSIR 80-2070. Issued June 1980. NTIS Order No. PB 80-204738.

This study considers the problem of evacuating the occupants from a multi-story building with multiple stairways in the event of fire. A dangerous situation may develop when the concentration of people at the entrances of stairs becomes too great. This study aimed to find out the factors which affect these concentrations and to obtain data to determine the reasonable width of stairs needed for safe evacuation.

An empirical determination of stairway concentrations was made by

an experiment conducted on the sixth floor (area - 3000 sq. meters) of a department store using as subjects 80 persons who were members of the Kobe-City Fire Department and who were unfamiliar with the building. Three theoretical calculating methods were also used to predict concentration and were based on these assumptions:

(1) number of persons going to a given stairs is proportional to the width of the stairs' entrance, (2) each person will run to the nearest stair from his starting point, and (3) person's choice of stairs can be affected by visibility of stairs' entrance as well as nearness. The third calculating method gave the closest approximation to the results of the experiment.*

*Annotation is author's abstract.

Index Words: Evacuation; experimental study; high-rise buildings.

72. Human Behavior in Fires. Fire Chief Magazine, Vol. 23, No. 1, 56-57, January 1979.

This article reports on the Second International Seminar on Behavior in Fire held at the National Bureau of Standards (NBS) in Gaithersburg, Maryland on October 29 - November 1, 1978. At this conference, sponsored by the NBS Center for Fire Research, researchers from the United States, Great Britain, Japan, Canada, the Federal Republic of Germany, and France gathered to discuss their research findings and problems. The article briefly discusses Saburo Horiuchi's report on an experimental study of evacuation behavior in a department store, John Bryan's study of the St. Joseph's Hospital fire, Joseph Scanlon's study of a fatal apartment building fire, and David Canter's and John Breaux's study of human actions in 29 fires occurring in varying types of occupancies.

Index Words: Evacuation; fire fatalities; fire incident study; hospital; residential occupancy.

73. Iacobell, F.P. and Schodowski, L. Fire Reaction Training That Really Works. Hospitals, Vol. 54, No. 3, 64-66, February 1, 1980.

Detroit's Hutzel Hospital developed a new training program designed to increase participation and provide more realistic training for its staff. The training proved effective when a major fire occurred.

The training was conducted in three phases over a five-month period. The first phase consisted of instruction in the use of fire extinguishers accompanied by an application exercise where staff actually employed extinguishers on burning mattresses, etc. In the second phase, employees studied the hospital fire plans. The final and most critical phase of the program consisted of instructions and practical exercises in the safe removal of patients in an emergency. Removal techniques were practiced on volunteers by staff at their own work locations.

Just a few weeks after the final segment of the training was completed, a major fire resulting in \$2.5 million in damages broke out in the hospital in an area used for educational and administrative purposes. It became necessary to relocate a total of 76 adults and 30 newborn infants. Floor and master census charts were continually updated to keep track of all patients during the transfer. The relocation process was so smooth that no patient missed a single medication dose during the entire emergency. Despite the size of the fire, only one employee sustained minor injury during the emergency when he slipped and fell on a wet floor.

Index Words: Fire emergency plans; fire incident; hospital; training and education.

74. Innes, J.M. Human Behavior under Stress. Fire, Vol. 67, No. 839, 601-603, May 1975.

This is a general, theoretical discussion of the reactions of people to stressful situations. References are made to social-psychological laboratory experiments.

The idea is presented that there is a certain optimum, intermediate level of fear at which the individual will accept warnings and advice from some authoritative source and modify his behavior, with any further increase in fear resulting in a rapid fall-off of such acceptance. This relationship between the degree of threat (fear) and the probability of behavior change is graphically pictured as a curvilinear relationship. A state of acute panic (with disorganization of perception, cognition and motor ability) would be represented by a rapid fall-off of the curve to a level below baseline behavior.

Group reaction to stress is also considered. Some research data shows that the presence of others decreases the probability of doing anything in an emergency (Darley and Latane).

The complex "panic" or entrapment situation is analyzed. An individual, behaving rationally according to his own interest by rushing an exit, rather than waiting his turn, can contribute to the failure of the group to escape. Thus, the separate actions of rational, thinking individuals can produce incoordination of group activity, with fear arousal not necessarily an element. Fear arousal is, however, an additional factor acting to increase incoordination further.

Index Words: Conceptual model; experimental studies; panic.

75. Jin, T. Evaluation of Fire Exit Signs in Smoke. In: CIB Symposium, Systems Approach to Fire Safety in Buildings. Proceedings. Japan. August 29-30, 1979. Vol. 2, Session 3.

An experimental study was conducted to determine the level of smoke density which would permit people not familiar with the inside geometry of a burning building to escape. This smoke density was found to be a low density likely to be encountered in the early stages of a fire.

The "psychological steadiness" of the experimental subjects in varying smoke densities was tested in the following manner. The subject sat at a table and manipulated a "steadiness tester" while the test room filled with smoke. He had to thrust a metal stylus into 4 holes of progressively smaller size in a metal plate in a specified order, trying not to touch the hole edges with the stylus. As smoke density increased, there was an increasing frequency of contact between the stylus and the hole edges. From the results, the author concludes that the limit of smoke density which would allow safe evacuation of the general public is 0.25/m or less (density as

measured by light extinction coefficient). For people who are very familiar with a building, the density of 0.5/m would be the threshold permitting safe evacuation.

The report also describes the results of tests on the visibility of emergency exit signs in smoke and gives an evaluation of the effectiveness of those signs.

Index Words: Communications; evacuation; experimental study; smoke, influence of.

76. Jin, T. Visibility Through Fire Smoke. *Journal of Fire and Flammability*. Vol. 9, 135-155, April 1978.

Experimental studies on the effects of smoke density on visibility are described. Signs in a smoke-filled chamber were observed from outside through a glass window. The mathematical product of visibility and smoke density was found to be almost constant. The value of the product depended mainly on the brightness of the object and the brightness of the illuminating light. The visibility of blue light through smoke was compared with that of red. Visibilities of red lighted signs were found to be 20 to 40% greater for smoldering smoke and 20 to 30% greater for flaming smoke than for those of blue lighted signs of the same brightness.

The effects of different types of smoke on visibility were also explored. A 20-meter long corridor was filled with smoke corresponding to an early stage of fire. A highly irritant white smoke was produced by burning wood cribs with narrow spacing between the sticks, and a less irritant black smoke was produced by burning kerosene. Subjects walked into the corridor from one end and recorded the places where they saw a lighted fire exit sign at the other end or where they were able to read the words on the sign. In the case of irritant smoke, the simple relationship between visibility and smoke density mentioned above can apply only at low smoke densities. Visibility in irritant smoke decreases sharply at the smoke density exceeding a certain level. In thick irritant smoke subjects had difficulty keeping their eyes open. Walking speed decreased as smoke density increased. At a given density, walking speed in thick irritant smoke was slower compared to that in non-irritant thick smoke. In irritant smoke, the subjects could no longer walk straight and began to go zigzag or walk along the wall. At low smoke density, the irritation factor was insignificant and walking speeds were about the same in both types of smoke.

Presented are some values for visibility distance and allowable smoke density for escape from fire proposed by various researchers. The visibility range needed would vary depending upon the occupant's familiarity with the layout of the building.

Index Words: Communications; experimental study; smoke, influence of.

77. Jones, C.E. and Fechter, J.V. Safe Environments--Anthropometric, Biomechanical, and Activity Considerations. National Bureau of Standards Report No. NBSIR 80-2014. September 1979. Issued June 1980. NTIS Order No. PB 80 199128.

This report provides a wide range of data obtained largely through literature searches on the characteristics of people and their activities in "normal" homes. The data are those which were considered to be most relevant to the problem of creating safe home environments, and in particular, to the establishment of safe non-institutional residences for the disabled. For example, in setting standards for emergency exit doors it is important to know the dimensions of people and the push forces they can exert on a panic door latch.

Data summaries are organized into four sections: Anthropometry and Biomechanics, Household Safety, Disability, and Household Operations. The first section provides data on such matters as maneuvering space needed for wheelchair occupants, and arm reach and force exertion capabilities. The second section concerns aspects of the home or its residents that are associated with accidents (use of alcohol, household equipment, etc.). The disability section presents information on the distribution of disabilities in the U.S. population as well as qualitative information on the cluster of physical and mental deficiencies associated with various disabling diseases or conditions. The household operations section provides data on the proportion of time spent in various household activities and household equipment use.

Index Words: Handicapped; literature review; residential occupancies.

78. Jones, J.C. 1979 Multiple-Death Fires in the United States. Fire Journal, Vol. 74, No. 4, 58-63, 66-69, 90, July 1980.

Detailed statistics are presented for the year 1979 for multiple-death fires (those fires that kill three or more people) in the United States. Overall, there were 271 multiple-death fires in the U.S. in 1979, and 1804 associated deaths, as reported to the NFPA.

In 1979, residential properties continued to account for the major portion of the multiple-death fires; 244, or 90% were in residential properties. The article contains a table showing leading ignition scenarios for residential multiple-death fires, 1971 to 1979, based upon a study of 683 residential multiple-death incidents reported to the NFPA from 1971 to 1979. The leading ignition scenario involved fires that originated in the living room, where a cigarette ignited upholstered furniture. The most common area of origin of residential multiple-death fires for 1979 (based upon 210 fires) was the living room. About 3/4 of the residential multiple-death fires (based upon 232 fires) occurred between 8 p.m. and 8 a.m., during which most people sleep.

Of special concern is the fact that four of the eight fires that resulted in 10 or more deaths in 1979 occurred in boarding facilities. The residents are for the most part capable of self-care, but may require some supervision. They include the elderly, the mentally retarded, the emotionally disturbed, etc. In many states, these facilities operate with a minimum of regulation. This article includes descriptions of these four boarding home fires: Boarding Home, Connellsville, Pennsylvania, April 1, 1979--10 fatalities; Boarding House, Farmington, Missouri, April 2, 1979--25 fatalities; Halfway House, Washington, D.C., April 11, 1979--10 fatalities; and Boarding Home, Pioneer, Ohio, November 11, 1979--14 fatalities.

Index Words: Boarding homes; fire fatalities; fire incident statistics; fire incident study; residential occupancies.

79. Kafry, D. Playing with Matches: Children and Fire. In: Fires and Human Behaviour, edited by David Canter, Chapter 4, pp. 47-61. New York, John Wiley & Sons, 1980. 338 pages.

The results of a research study which investigated fire behavior and knowledge in a sample of young, normal boys are presented. A random sample of 99 boys from the kindergarten, second and fourth grades of the Berkeley, California school district participated in the study. Fire-play (the lighting of matches without parental approval and/or supervision) was performed by 45% of the boys studied. Fires, which were mostly small and easily extinguished, were set by 21% of the boys studied. Thus, the study indicated a high prevalence of fireplay which often resulted in actual fires.

Children's interest in fire was found to be uniformly high in all three age groups. The study showed a decreasing tendency in the number of fires set beyond the age of seven with none being set after age eight from this sample.

The chapter contains a general discussion of the characteristics of children who play with matches and their family backgrounds, drawing from the general research literature as well as the Berkeley study. It has been found that "match-players" tend to be more energetic, adventurous, and impulsive than usual. The lack of "impulse control" found among these children implies the need for the setting of disciplinary "limits" and for the provision of many constructive outlets for their energies. It may be more effective for fire prevention in some cases to provide the child with the opportunity for a controlled, experimental use of fire rather than completely prohibiting its use.

Index Words: Experimental study; fire incident statistics; firesetters; literature review; training and education.

- 79a. Keating, J.P. and Loftus, E.F. The Logic of Fire Escape. Psychology Today, pp. 14-19, June 1981.

Human behavior in recent hotel fires is discussed as well as the authors' own experimental research in the areas of interview techniques, recall of fire incident events, and people's knowledge of appropriate behavior in fires.

Some of the deaths in fires at the MGM Grand Hotel and the Hilton in Las Vegas could be attributed to panic (those who jumped) or incorrect evacuation procedures (those who used elevators). However, others died who did not panic or use improper procedures. "In both blazes, most of the victims were found dead on the upper floors... overcome by toxic gases that rushed into their rooms through air-handling equipment, stairwells, and elevator shafts. Nine people at the MGM followed fire-safety directions and used the stairwells to escape, but the stairs were unprotected from smoke, and all nine died in the enclosures above the 20th floor."

In their own research, the authors have developed a method of interviewing fire incident participants that attempts to minimize distortions in memory. The person is first asked to give an account of the incident in his own words. The interviewer then goes back through this account with the person, recording in order, the cues responded to, the response, and the person's reason for doing what he did. The authors have found little evidence of panic. With rare exception, survivors give rational explanations for their behaviors.

With the intent of exploring methods of enhancing people's memories of fires, a study was conducted in which a group of subjects--including U. of Washington students and arson investigators--viewed a very disturbing film of a fire and were then tested on their recollections of the film. The trained arson investigators were no more accurate than the student population on nontechnical matters but more accurate on items that specifically relate to firefighting, such as the number of hose lines ordered into and out of the building. (It is easier for a person to assimilate new knowledge when it is related to knowledge he already has.) Thus, as people become more educated about fires, they can be expected to recall fire-related information with greater accuracy.

Index Words: Experimental studies; fire fatalities; fire incident study; high-rise buildings; panic; training and education.

- 79b. Keating, J.P. and Loftus, E.F. Vocal Alarm Systems for High-Rise Buildings-- A Case Study. Mass Emergencies, Vol. 2, 25-34, 1977.

This article discusses desirable characteristics for vocal alarm systems (VAS) for high-rise buildings, and presents as a case study the operation of a VAS in the Seattle Federal Building.

The system includes an initial alerting sound, and various prerecorded emergency messages for occupants of elevators, the fire floor, adjoining floors, and floors receiving occupants from evacuated areas. Total evacuation of the building is not planned. Occupants are generally only moved from the fire floor and adjacent floors. The authors were asked to make recommendations for the system regarding the most effective warning signal, the content of the instructional messages, and voice qualities of the communicator.

This VAS system was evaluated using two unannounced fire drills within a period of one hour in the Seattle Federal Building. Two sections of the building were involved in the two separate fire drills, floors 20-24 and floors 14-18, with floors 22 and 16 respectively being designated as the fire floors. Only occupants of floors 20-24 had been given training prior to the drills. No instruction on the new system had been given to occupants of floors 14-18. Observations were made by the investigators, General Services Administration personnel, and the Seattle Fire Department personnel. In addition, questionnaires were distributed to participants after the drill.

It was concluded that there were no observable differences in the behavior and evacuation between persons given orientation about the new alarm system and those provided with no such orientation. Thus it seems that the vocal alarm system itself and not the prior orientation was principally responsible for the rapid, orderly evacuation which was observed. Analysis of the questionnaire showed no significant differences between the two groups on any question. Respondents felt that this drill was less confusing than others they had been in and expressed a preference for a VAS over a usual bell emergency signal.

See also reference 93.

Index Words: Alarms; area of refuge; communications; evacuation; experimental study; fire drills; fire emergency planning; high-rise building; training and education.

80. Keating, J.P. and Loftus, E.F. Vocal Emergency Alarms in Hospitals and Nursing Facilities: Practice and Potential. University of Washington, Seattle. National Bureau of Standards Report No. NBS-GCR-77-102. July 1977. Final Report. NTIS Order No. PB-273165.

This is the full report of the study conducted by John Keating and Elizabeth Loftus of the University of Washington, Seattle, on vocal emergency alarms in hospitals and nursing facilities. (This study was reported on in the July 16, 1978 issue of the Journal of the American Hospital Association. See item, "Groner, N.E..." in this bibliography.) This full report presents seven recommended guidelines for the development of fire alarm messages and a sample message. The evidence for the validity of these recommendations is given.

Index Words: Alarms; communications; experimental study; hospitals; nursing homes.

81. Kobayashi, M. and Horiuchi, S. Analysis of Occupant Behavior in an Office Building Under Fire. In: Second International Seminar on Human Behavior in Fire Emergencies, October 29 - November 1, 1978 -- Proceedings of Seminar, pp. 187-201. National Bureau of Standards Report No. NBSIR 80-2070. Issued June 1980. NTIS Order No. PB 80 204738.

This paper analyzes the occupant behavior which occurred in an office building fire. Data was obtained from a questionnaire distributed to occupants of an insurance company building in Osaka, Japan, in which a fire occurred on April 6, 1978. The building contained 9 stories above and 5 underground. The fire occurred at the kitchen's ventilation duct in the second basement, and smoke spread through the building through the duct and a staircase. Approximately 2000 occupants escaped from the building without injury.

The interrelationships among three items--occupation and sex, first action after perceiving fire, and evacuation behavior--were analyzed to find characteristic behavior patterns. Two types of behavior patterns were extracted. They were: the behavior of those in the occupations of store owner and male store clerk to take responsible actions when they perceived a fire, and then to escape via the route that they had previously decided to take in fire situations; and the behavior of female office clerks to wait for superior officers' instructions and then escape by following instructions and guidance. (The specific behaviors within these patterns were not the most common behaviors.)*

*Annotation is author's abstract.

Index Words: Evacuation; fire incident study; high-rise buildings.

82. Latane, B. and Darley, J.M. Group Inhibition of Bystander Intervention in Emergencies. *Journal of Personality and Social Psychology*, Vol. 10, No. 3, 215-221, 1968.

Some experimental studies are presented which indicate that a person is less likely to intervene in or respond in some way to an emergency situation if other people are present. For a person to intervene in an emergency, he must "notice" the event, "interpret" it as an emergency, and decide that it is his "responsibility" to act. These stages of the decision process are explored.

In one experiment, subjects heard a person undergoing a severe epileptic-like fit in another room. In one experimental condition, the subject thought he was the only person to be aware of the emergency; in another condition, the subject knew that four other persons were also aware of the seizure (but he could not interact with the other four persons). Subjects alone with the victim were much more likely to intervene on his behalf, and on the average reacted in less than 1/3 the time required by subjects who thought others were present. The principle of "diffusion of responsibility" is offered as an explanation for this result. When an individual believes others are present, he may feel his own responsibility for taking action is lessened.

Another experiment focussed on the second step of the decision process, interpreting an ambiguous event. Male undergraduate students found themselves in a smoke-filling room either alone, or with two nonreacting others (confederates of the experimenters), or in groups of three (all naive). When alone, 75% of the subjects reported the smoke; in the presence of two nonreacting others, only 10% did; while in groups of three, in only 38% of the eight groups in this condition did even one subject report the smoke during the experimental period. In general, seeing other people remain passive apparently led subjects to interpret the smoke as not dangerous.

Index Words: Experimental studies; smoke, influence of.

83. Lathrop, J.K. Two Fires Demonstrate Evacuation Problems in High-Rise Buildings. *Fire Journal*, Vol. 70, No. 1, 65-70, January 1976.

This is an account of two fires in New York City high-rise buildings: the fire in the World Trade Center's South Tower on April 17, 1975 and the fire in the Squibb Building on July 11, 1975.

The World Trade Center fire demonstrated the fact that even though reassurances are provided through a public address system, it may still be difficult to convince people they are not in danger when they see an obvious problem such as smoke. In this case, a small trash fire on the fifth floor resulted in the needless evacuation of the ninth through the twenty-second floors because of occupants' concern over smoke. The fire safety director had initially urged

people to return to their offices; when it became obvious they were not going to do so, he ordered the evacuation.

In the Squibb Building fire, approximately 40 employees became trapped on the fire floor (18th floor) when both stairways became inaccessible--one, due to the location of the fire and, the other, due to a door having been blocked open. The occupants appropriately retreated to a large office in the corner of the building, stuffed clothing around door cracks and into vents to stop smoke from entering the room, and broke out some windows. They were able to survive until Fire Department rescue. This building had no evacuation alarms and no general public address system.

Index Words: Area of refuge; communications; evacuation; fire incident study; high-rise buildings; smoke, influence of.

84. Lathrop, J.K., Harrison, G.A. and Custer, R.L.P. In Osceola, A Matter of Contents. Fire Journal, Vol. 67, No. 3, 20-26, 91, May 1975.

This article describes a fatal fire which occurred on December 2, 1974, in a modern one-story hospital in Osceola, Missouri, whose construction essentially complied with the NFPA Life Safety Code No. 101-67. Seven of the nine patients in the wing of origin died of smoke inhalation; another died when his oxygen supply was inadvertently cut off.

Staff became aware of the fire through smell and sight of smoke. They were unable to cope with this rapidly developing fire with very heavy smoke production. They fled past smoke barrier doors which were automatically closing and were prevented by the heavy smoke conditions from returning to the corridor. None of the patient room doors on the fire corridor were closed. Contrary to the hospital's fire plan the fire department was not notified immediately. Rather, the nurse in charge first placed a call to the head nurse at her home, then to the county sheriff, and finally to the volunteer Fire Department. An oxygen valve, mistaken by a nurse's aide for a fire alarm because the plastic cover over the valve was red, was shut off. This resulted in a patient death. The registered nurse in charge of the shift had not attended the 11 fire drills held in the last year, and the licensed practical nurse who was second in command was new at the facility.

Index Words: Alarms; fire fatalities; fire incident study; hospital.

85. Lerup, L. People in Fires: A Manual for Mapping. University of California at Berkeley. National Bureau of Standards Report No. NBS-GCR-77-106. 1977. NTIS Order No. PB-275155.

This manual is the second of two reports which describe the technique called mapping developed by Lerup and his colleagues to assist fire analysts in their reporting of fire incidents. (For a

description of the first report, see entry "Lerup...NBS-GCR-76-73.") The technique is intended to be an additional tool rather than a substitute for the report systems already in use. While the first report provides the conceptual framework and rationale for mapping, this report illustrates the technique itself. It provides step by step instructions for the investigation, data-gathering and organization, and graphic mapping procedures involved in this graphic presentation of both the fire development and human behavior patterns in fire incidents. The case used as an example throughout is the Geiger Nursing Home fire which took place in Texas Township, Pennsylvania on October 19, 1971.

Index Words: Conceptual model; fire incident study; Lerup mapping technique; nursing home.

80. Lerup, L., Cronrath, D., and Liu, J.K.C. Fires in Nursing Facilities. In: Fires and Human Behaviour, edited by David Canter, Chapter 10, pp. 155-180. New York, John Wiley & Sons, 1980. 338 pages.

Ten fatal nursing home fires were analyzed for the purpose of developing recommendations for building design which would improve fire safety. Data was drawn from a variety of sources including newspaper clippings, interviews with survivors and reports by experts in the fire field. Supporting data were drawn from the Fire Incident Data Organization (FIDO) file maintained by the National Fire Protection Association (NFPA).

A model was developed to structure both the data regarding human behavior in fires and the development of the fire itself. Graphic representations (maps) of the series of human actions and the fire development are presented together in a time sequence so that it is possible to consider the relationships between fire development and human actions. The major types of human behaviors are divided into "episodes," i.e., periods where a specific goal is being pursued. The types of episodes identified by Lerup are: investigation, alarm, attack, flight, rescue, and no action. At the beginning or end of each episode are "decision points," at which time it is decided to pursue a new course of action. Similarly the fire development is organized into "realms" divided by "critical events" which mark changes in the course of a fire. For example, flashover would be a critical event.

The data organized by this model was further analyzed by the use of "design maps," which illustrate the lifesaving actions performed in relation to the existing environmental conditions and suggest some possible changes to the environment which could have favorably affected the outcome of the fire incident.

From this analysis, seven design implications were generated from the ten case studies, and organized into their order of importance. The design implications placed at the head of the list were: a

feedback signal, telling staff that the fire department has been notified, and a nursing station located centrally in each major compartment. It is emphasized that any physical change to be effective needs to be accompanied by behavioral changes involving both the knowledge of occupants and the management of the facility.

Index Words: Conceptual model; fire fatalities; fire incident study; studies; Lerup mapping technique; nursing homes.

87. Lerup, L., Cronrath, D. and Liu, J. K. C. Human Behavior in Institutional Fires and Its Design Implications. University of California at Berkeley. National Bureau of Standards Report No. NBS-GCR-77-93. February 28, 1977. Final Report. NTIS Order No. PB-271980.

The object of this study was to derive design implications from the analysis of behavior in institutional settings under fire. Data was drawn from 10 case studies of significant nursing home fires which occurred in the U.S. between 1970 and 1974. This report describes the model used for the analysis of the interaction between human behavior and the fire. The "maps" for the 10 nursing home fires which illustrate both human behavior and fire development are included. Data are also derived from 23 nursing home fire cases showing frequency and sequence of patient and staff life saving actions (investigation, alarm, attack, flight, rescue, no action).

The major behavioral findings from the 10 case studies were: the tendency for staff to call the fire department even when it has already been notified, and the apparent need of staff to investigate face-to-face and verify the existence and severity of the fire emergency despite assurances from patients and even automatic alarm systems. The report presents 7 major design implications. These include: a feedback signal from the fire department to the staff, and a nursing station located in each major compartment (derived from the behavioral findings given above).

Index Words: Conceptual model; fire incident study; Lerup mapping technique; nursing homes.

88. Lerup, L., Greenwood, D. and Burke, J. S. Mapping of Recurrent Behavior Patterns in Institutional Buildings Under Fire: Ten Case Studies of Nursing Facilities. University of California at Berkeley. National Bureau of Standards Report No. NBS-GCR 76-73. July 1976. Final Report. NTIS Order No. PB-257424.

This report presents a descriptive analysis, using a technique called mapping, of ten previously conventionally reported case studies of fires in nursing homes which occurred between 1970 and 1974. Mapping refers to the graphic display of the state of the physical setting and the location and activity of occupants at certain crucial times during the fire incident. In the conceptual

framework of mapping, the development of the fire is divided into segments called "realms," while the human behavior sequences are divided into "episodes." "Critical events" are division points between "realms" in the description of the fire, and "decision points" similarly divide "episodes" in the description of behavior. With respect to the Harmar House Fire and the Geiger Home Fire, in addition to the mappings, case study source notes are included which provide examples of the nature of the information used to produce the maps.

Index Words: Conceptual model; fire incident study; Lerup mapping technique; nursing homes.

89. Levin, B.M., Editor. Fire and Life Safety for the Handicapped. National Bureau of Standards Special Publication 585. Issued July 1980. 154 pp. U.S. Government Printing Office, Washington D.C. GPO No. SN 003-003-02210-1.

Federal, state, and local regulations have worked to make buildings used by the public increasingly accessible to the handicapped. This has led to concern over whether there is adequate provision for the life safety of the handicapped under fire conditions in these same buildings. To address these life safety concerns, on November 26-29, 1979, a conference on Fire and Life Safety for the Handicapped was held at the National Bureau of Standards in Gaithersburg, Maryland. The work of the conference was accomplished by seven panels meeting in parallel sessions. Conference participants were assigned to panels in a manner to insure that each panel would have members with a wide range of backgrounds (engineering, codes, advocacy, etc.) so that ideas could be evaluated from a number of perspectives.

This publication is a product of the conference and is designed to be a basic source document for this area of concern. It contains: the reports of the seven panels which met during the conference (overview, alarm systems, egress, refuge, self-protection, management actions, and emergency service actions); the reports of six workshops which were held in preparation for the conference during August and September 1979 (codes and standards, emergency preparedness planning, building design, education, consumer interests, and products); conference speeches; and supplementary commentaries by some of the participants.

The panel reports define problem areas and issues and present findings and recommendations. Major points are made regarding:

basic philosophy -- The issue of the disabled person's "right to risk" and the effects of measures to make his risk "reasonable" on non-disabled persons are considered.

research and data needs -- Data is needed in such areas as the basic performance capabilities and limitations of handicapped people in coping with fire emergencies, the number and distribution of handicapped persons in buildings, past experiences of the handicapped in fire situations, and the interactions of handicapped and non-handicapped persons in fire emergencies.

specific problem areas -- For example, many current alarm systems with their steady non-coded signal inhibit communications between building occupants; any audible alarm system may disorient the blind who depend on normal building noises for navigation. Elevators used to give access to the disabled are generally not considered safe to use in fire emergencies.

implementation problems and strategies -- Possible incentives to buildings owners and managers to make building improvements, to carry out proper maintenance, and to include the handicapped in emergency planning are described. The special educational and training needs of the handicapped and the responsible managers are considered.

Index Words: Alarms; area of refuge; codes and standards; communications; evacuation; fire emergency planning; handicapped; risk; training and education.

90. Levin, B.M. and Paulsen, R.L., Editors. Second International Seminar on Human Behavior in Fire Emergencies, October 29-November 1, 1978-- Proceedings of Seminar. National Bureau of Standards Report No. NBSIR 80-2070. Issued June 1980. 282 pp. NTIS Order No. PB 80-204738.

This is a compilation of the papers given by researchers at this conference. Each paper has been referenced separately under the author's name.

The authors are: Beard, A.N.; Berlin, G.N.; Burgun, J.A.; Canter, D.; Chandessais, C.; Collins, B.L. and Pierman, B.C.; Finucane, M. and Marchant, E.W.; Haber, G.M.; Helzer, S.G.; Horiuchi, S.; Kobayashi, M.; Quarantelli, E.L.; Black, C.M.; Bryan, J.L.; Mawson, A.R.; Sime, J.D.; Wenger, D.; Seeger, P.G. and John, R.; Stahl, F.I.; and Van Bogaert, A.F.

91. Loader, K. Behaviour of People in Fires. Fire Prevention, No. 127, 26-29, October 1978.

Reference is made to an article by N.C. Strother Smith (Fire Prevention, No. 121) which concluded that appropriate training could considerably reduce the unpredictability of behavior of people in fires. The present article builds upon this previous article by presenting 5

additional case studies which support the value of training. The fires occurred in: a mental hospital in Surrey, England on February 8, 1978; a supper club in Southgate, Kentucky on May 28, 1977; a multi-occupancy building in Manchester, England on January 20, 1977; a hotel in Amsterdam on May 9, 1977; and a house in North Carolina on December 8, 1977. The author also outlines factors in fire safety that need further consideration in controlled situations (e.g., workplaces) and less easily controlled places (e.g., homes).

Index Words: Fire incident study; hospital; residential occupancy; training and education.

92. Loftus, E.F. Words That Could Save Your Life. Psychology Today, Vol. 13, No. 6, 102-103, 105-106, 110, 136-137, November 1979.

The relatively new notion that the wording and method of delivery of evacuation messages for emergency situations in places of public occupancy are of great importance, and the proper concern of social psychologists, is considered.

After a fire aboard a San Francisco Bay Area Rapid Transit System (BART) subway train in January 1979, the California Public Utilities Commission ordered the tunnel closed until BART authorities could demonstrate that the subway system was safe. An engineering firm hired to draft a safety plan devised an evacuation message which was found to be unsatisfactory. A test fire drill using this message had been conducted, and it was concluded that the message was too long and confusing. The author was hired to develop an improved message. Her message was judged to be an acceptable part of an evacuation plan, although the message was not tested because of the expense of running another drill. The evacuation plan was accepted, and service was resumed on BART.

The accepted message contained these elements: a statement of exactly what was happening; the use of the term "Bart Central" to give passengers the feeling that there was an authority in control; the destination of the evacuation movement; and an announcement that the instructions would be repeated to reassure passengers that they would hear the instructions again, in case they missed an important detail. One problem remaining with the new system is that the message is not prerecorded but is to be recited by train drivers who could become emotional under stressful conditions.

In making her recommendations for BART, the author benefited from her earlier work with J. Keating and N. Groner, developing evacuation messages for high-rise buildings and hospitals. This earlier work is also described in the article.

Index Words: Communications; evacuation; fire emergency planning; high-rise buildings; hospitals.

93. Loftus, E.F. and Keating, J.P. The Psychology of Emergency Communications. In: Proceedings of the Public Buildings Service International Conference on Firesafety in High-Rise Buildings, November 1974. Washington, D.C., General Services Administration, Public Buildings Service, 1974.

The problem of emergency communications in high-rise buildings where total evacuation is not considered desirable is considered.

The desirable components of an emergency communications system for high-rise buildings are listed. These include pre-recorded voice announcements which can be used automatically to respond to manual or automatic fire alarms, and a voice system to modify or update information. The 37-story Seattle Federal Building was designed to incorporate these components.

Presented are sample dialogues for pre-recorded messages directed towards people in elevators at the time a fire is reported, and toward those on the fire floor and adjacent floors. The rationale for the wording of the messages is given.

Another section of this report discusses the alerting tone which precedes the voice messages and is designed to capture the attention of the people. The recommendation is to use the Federal Communication Commission warning signal (1000 Hz pure sine wave tone) as the alerting tone.

Index Words: Alarms; communications; high-rise buildings.

94. Mande, I. A Standard Fire Alarm Signal, Temporal or "Slow Whoop." Fire Journal, Vol. 69, No. 6, 25-29, November 1975.

This article contains the text of the speech given by Irving Mande, Chairman of the NFPA Sectional Committee on Protective Signaling Systems, at the 1975 NFPA Annual Meeting, May 12-16, Chicago. The paper gives a history of the development of this committee's proposal which recommended a standard fire alarm signal based on a distinct temporal pattern rather than a distinct sound. An advisory group, the Committee on Hearing, Bioacoustics, and Biomechanics, of the Assembly of Behavioral and Social Sciences of the National Research Council, (CHABA) had concluded that to satisfy the requirement of detectability, it would be best not to limit the standard to any one sound, such as the electronically generated "Slow Whoop," but to allow the most suitable sound to be used at each location, and to interrupt whatever sound was required in an easily recognizable pattern.

Index Words: Alarms; codes and standards.

95. Marchant, E.W. Human Behaviour in Fire. Fire, Vol. 70, No. 865, 76, July 1977.

This is an account of an international meeting on human behavior and fire safety held in the spring of 1977 at the University of Surrey, England. Twenty researchers, representing the U.S., Canada, Austria, and the United Kingdom, discussed recently completed or on-going research.

Some of the topics covered were: systematic analysis of fire safety problems; observational research on crowd movement; computer programs with relevance for escape route design; and, in particular, fire safety in health care buildings.

Index Words: Hospitals; overview - behavior in fire.

96. Marchant, E.W. Modelling Fire Safety and Risk. In: Fires and Human Behaviour, edited by David Canter, Chapter 16, pp. 293-314. New York, John Wiley & Sons, 1980. 338 pages.

A variety of models are used by researchers and fire protection engineers to represent the complex real fire situation. These models vary from representation of small parts of the combustion process to representations of the full range of components in a fire situation--including people and building factors. Models can help the fire safety engineer to identify weaknesses in the relationships between the components and determine which factors to adjust to produce a desired level of safety with the least amount of resources. The information used in modelling can come from a variety of sources such as statistics, experiments, observations of real fires, and professional value judgments. Processing input information can involve a consideration by individuals or industry of what constitutes an "acceptable" risk.

Some of the systems approaches to fire safety discussed are: the fire death scenarios of Clarke and Ottoson, the National Bureau of Standards (NBS) evaluation system for health care facilities, and fault-tree analysis. The Clarke and Ottoson scenarios help identify those areas of fire investigation which should be given a high priority. The elements of the scenario are--type of loss, type of occupancy, ignited agent, and ignition source. Using this analysis, a major death scenario has been found to be the situation in residences where smoking materials have ignited furnishings. The NBS evaluation system may be considered a comparative model. It identifies various occupancy factors which contribute to life safety risk and compares this occupancy risk with the general level of safety provided by various features of the building. The objective of the system is to provide an alternative, which emphasizes performance capability, to strict adherence to the construction standards specified in the

National Fire Protection Association (NFPA) Life Safety Code. There is also a brief discussion of fault-tree analysis. (See reference: Beard, A.N. A Suggested Methodology for Approaching Fire Safety and Its Relation to Fault-Tree Analysis ... for an explanation of fault-tree analysis.)

Index Words: Codes and standards; conceptual model; egress model; risk.

97. Marchant, E.W. Some Aspects of Human Behaviour and Escape Route Design. In: International Fire Protection Seminar, 5th. Vol. 2, pp. 85-101. Sponsored by the Vereinigung zur Forderung des Deutschen Brandschutzes e.V. Karlsruhe, West Germany, September 22-24, 1976.

This paper presents an analysis of escape from fire as a time dependent activity. It describes sensory, psychological, physiological, and physical factors contributing to the time for occupants to perceive, react to, and escape from a fire situation. The concepts of "effective number of people" and "time block analysis" are introduced as aids to escape design. The need for the concept of effective number derives from the fact that a heterogeneous crowd in a large retail store will contain a small percentage of mobility impaired people who cannot move at the optimum rate. An effective number of people (larger than actual) is a way of accommodating these differences so that design intensities can be increased. Time block analysis is a simple method of assessing the number (or effective number of people) on any part of an escape route at any time after commencement of evacuation.

Index Words: Egress model; evacuation; handicapped.

98. Mawson, A.R. Is the Concept of Panic Useful for Scientific Purposes? In: Second International Seminar on Human Behavior in Fire Emergencies, October 29 - November 1, 1978 -- Proceedings of Seminar, pp. 208-211. National Bureau of Standards Report No. NBSIR 80-2070. Issued June 1980. NTIS Order No. PB 80 204738.

The term "panic" refers to fear and/or flight behavior that is either (a) inappropriate and maladaptive, or (b) highly intense. Both senses of the term are unreliable as descriptions of actual events. There is the problem of what criteria to use in determining the appropriateness of the behavior, and from whose point of view the behavior is to be judged--that of the participant or the observer. The term "flight" is recommended as an evaluatively-neutral substitute for "panic." Current explanations of flight emphasize the perception of imminent danger and limited escape routes. However, whether or not flight occurs in a situation of danger seems to depend largely on the whereabouts of attachment objects (familiar persons and

places). If attachment objects are present in the situation, the likelihood of flight is reduced; if they are absent, the probability of flight is increased.*

*Annotation is based on the author's abstract with modifications and/or additions.

See also reference: Quarantelli, E.L. Five Papers...

Index Word: Panic.

99. McDaniel, M.A., Bickman, L., Edelman, P. and Herz, E. An Exploration of Non-sampling Error in Fire Incident Surveys. Loyola University of Chicago. National Bureau of Standards Report No. NBS-GCR-78-135. December 1977. Final Report. NTIS Order No. PB-284849.

This report provides information relevant to the problem of non-sampling error in fire incident surveys. It details survey findings related to fire victims' reporting biases of fire incidents. The telephone numbers of household fire victims in a midwestern city, during the months of September 1975 through August 1976, were obtained from the fire department. All eligible and cooperative respondents were asked a series of questions concerning whether they experienced a fire during the target interval and, if they had a fire, they were questioned about it. Approximately one-half of the respondents who, according to fire department records, had had a fire failed to report it to the interviewer. Results indicated that respondents who had more serious fires, reported the incident to the interviewer significantly more often than respondents who had less serious fires. Also, fires which occurred later in the 12 month reference period (i.e., closer to the time of the interview) were more often reported to the interviewer than those which occurred earlier in the reference period. In most cases the fire reporters' responses agreed with fire department records concerning the characteristics of the fire incident; however, total agreement was seldom found.*

*Annotation is based on authors' abstract.

Index Words: Fire incident statistics; residential occupancies.

100. McDaniel, M.A., Bickman, L., Edelman, P. and Herz, E. A Survey of Fire Preparedness in a Midwestern City. Loyola University of Chicago. National Bureau of Standards Report No. NBS-GCR-78-136. December 1977. Final Report. NTIS Order No. PB-285458.

This report presents the results of a survey undertaken to explore the nature and extent of fire preparedness in a midwestern city. The survey explored respondents' attitudes toward fire safety, their knowledge of appropriate behavior in fire emergencies, and

their fire preparation practices and hardware as well as other items relating to fire preparedness. The survey was administered to persons from a randomly selected sample of households as well as to a sample of persons known to have been victims of fires. It was concluded that there were no apparent response differences between the fire victims and the random sample of household respondents on the variables measured. While respondents reported favorable attitudes toward training and prevention, a significant number showed a lack of knowledge of appropriate behavior in fire emergencies as measured by responses to scenarios.*

*Annotation is based on authors' abstract.

Index Words: Fire emergency planning; residential occupancies; training and education.

101. Meisen, W. and Reinsel, R. Emergencies in Tall Buildings: The Designers Respond to the Human Response. In: Human Response to Tall Buildings. Conway, D.J., Editor. Ch. 23, pp. 302-309. Stroudsburg, PA, Dowden, Hutchinson & Ross, Inc., 1977.

This chapter contains a paper prepared under the auspices of the Public Buildings Service (PBS) of the U.S. General Services Administration (GSA). It contains a brief account of the 3 major high-rise safety conferences sponsored by GSA since 1971. It gives the essential elements of a GSA "Building Firesafety System." The Seattle Federal Building was designed as a prototype of this system. Categories of response to fire emergency are described. These range from leadership role to complete withdrawal. The proportion of persons in these categories is dependent upon an adaptive time factor and a group composition factor. The authors list the essential attributes of a Vocal Alarm System (VAS) which is part of the GSA fire safety prototype. Examples of the language used in the VAS and the rationale behind the choice of language are presented. Details of the positive results of VAS field tests are also presented.

Index Words: Communications; fire emergency planning; high-rise buildings.

102. Nagarvala, P. Data Sources and Statistics on Human Behavioral Aspects of Fire Safety in the U.S.A. Report No. UCB FRG WP 74-5. University of California, Berkeley. August 1973.

This report gives data on dollar losses and causes of building fires in the U.S. (1955-1970). It describes problems in gathering statistics of fire-related deaths; e.g., deaths due to jumping from high places to escape fire officially reported as being caused by "injury" or "falls." It proposes sources from which information on human and monetary losses to fire may be obtained. Data indicate that time between ignition and detection is far more crucial than

interval between detection and arrival of professional help with respect to the probability of fire spread. Data are given on the probability of fire spread beyond the room of origin for different sources of ignition, and on the probability of a large fire (involving losses over \$24,000) vs. the probability of a fire spreading outside its original ignition room for different construction/occupation conditions. The relationship between fire loss and probability of fire spread is such that even a small decrease in spread would pay off well in terms of preventing large losses.

Index Words: Fire fatalities; fire incident statistics.

103. Nober, E.H., Peirce, H., Well, A., Johnson, C.C. and Clifton, C. Waking Effectiveness of Household Smoke and Fire Detection Devices. University of Massachusetts. National Bureau of Standards Report No. NBS-GCR-80-284. September 1980. Issued October 1980. NTIS Order No. PB 81-127565.

This is a report on an experimental study of the waking effectiveness of home smoke detector alarms of varying dBA levels, both under quiet background conditions and with background noise.

"Normal-hearing, young adults were subjected to home smoke detector alarm signals of 85, 70, and 55 dBA while asleep in their own bedrooms under quiet background conditions. In addition, other adults received 70 and 55 dBA alarm signals masked by window air conditioner background noise. Each person, upon awakening from the alarm signal, was instructed to shut off the alarm and telephone the local fire department. The 85, 70, and 55 dBA alarm levels were all sufficient to awaken the subjects at varying hours of the night and days of the week, under quiet background conditions. While there were statistically significant differences in waking times between 55 dBA and the other two alarm levels, the total times never exceeded 115 seconds for the combined alarm shutoff and the fire department telephone call at any alarm level. With background noise, waking times for the 70 and 55 dBA alarm levels increased (85 dBA not tested). At 70 dBA, the total time for the alarm shutoff and the fire department telephone call ranged from 36 to 119 seconds. At 55 dBA, two persons failed to awaken and one person awakened after the four-minute test termination criteria. For the remaining seven persons, the total time for the combined alarm shutoff and the fire department telephone call ranged from 45 to 137 seconds."*

*This paragraph is the authors' abstract.

Index Words: Alarms; experimental study; residential occupancies; smoke detectors.

104. Ottoson, John Three Residential Fires-The Human Factor. Fire Journal, Vol. 69, No. 3, 5-9, 105, May 1975.

This article provides details regarding three residential fires, with fatalities occurring in two of these. An analysis of the 3 major factors involved in the safe escape of people from their homes in event of fire is given with references to these three fires. They are: (1) a detection system sensitive enough to detect a fire still small enough to permit escape (unfortunately, in the second fire the detector battery had been removed); (2) adequate resident knowledge and planning (first fire - failure to close door, second fire - each thought the other had rescued child); and (3) fire protection equipment maintenance and Fire Department capability. Residents must know how to escape without assistance from fire fighters since rapidly growing fires often make Fire Department rescue too late.

Index Words: Fire emergency planning; fire fatalities; fire incident study; residential occupancies; smoke detectors.

105. Overboe, C.J. and Wang, Y.Y. Behavioral and Physical Characteristics of Developmentally Disabled Individuals. Waisman Center, University of Wisconsin-Madison. National Bureau of Standards Report No. NBS-GCR-79-167. October 1978. Issued March 1979. Final Report. NTIS Order No. PB 294970.

This report presents an overview of the behavioral and physical characteristics of developmentally disabled individuals. The study consisted of a comprehensive search and review of the research literature related to mental retardation, cerebral palsy, epilepsy, autism, and multiply-handicapping conditions. The goal of the study was to provide a baseline of information to assist decision-makers in determining realistic requirements for fire/life safety in community housing for the developmentally disabled.

Index Words: Boarding homes; handicapped.

106. Pauls, J.L. Building Evacuation: Research Findings and Recommendations. In: Fires and Human Behaviour, edited by David Canter, Chapter 14, pp. 251-275. New York, John Wiley & Sons, 1980. 338 pages.

Results from numerous studies of evacuations from high-rise office buildings in Canada over the past ten years are considered. The chapter focuses on factors affecting flow rates, and a formula for predicting total evacuation time under certain specified conditions is derived.

Confusions in earlier research which can lead to predictions of

unrealistically high flow rates are discussed: (1) Test results from ideal experimental conditions may not be applicable to normal situations. (2) There has been confusion between "peak or maximum flows" and "sustained mean" flows. Flows that are only briefly sustained maxima have been used for design or performance prediction. Another possible source of error is to base calculations on "measured stair width" as opposed to "effective stair width." Observations of evacuations indicate that there is a border area near each wall which is not used by evacuees. This area should be subtracted from the stair width to obtain the "effective width" (measured width minus 300 mm. or 12 in.).

Other factors affecting flow rate are discussed. The size of the evacuation population was found to have a positive effect upon the flow rate. An increase in evacuation population (persons/meter of effective stair width) led to an increase in mean evacuation flow (persons per sec. per meter of effective stair width) with the effect being most pronounced for small populations. The wearing of coats and the existence of rough textured stairway walls decrease evacuation flow rates. Stairs that discharge through a main lobby at ground level tend to have a higher evacuation population and a higher flow. Density of people on stairs is a factor which can be expected to influence speeds and thus flow rates. The observed effects of density on speeds and flow rates are presented graphically. An optimum density for best flow is derived.

A formula for predicting total evacuation times based on observed evacuation times for Canadian office buildings is given. The formula applies to office buildings where the total evacuation procedure* is used, the building is under 15 stories, and the evacuation population is less than 800 persons per meter of effective stair width. The model assumes capacity flows after an initial delay period between the sounding of the alarm and a buildup to capacity flow.

*See reference: Pauls, J.L. and Jones, B.K. Building Evacuation: Research... for a definition of this procedure.

Index Words: Egress model; experimental studies; evacuation; fire drills; high-rise buildings.

- 106a. Pauls, J.L. Management and Movement of Building Occupants in Emergencies. National Research Council of Canada, Ottawa. Report No. NRCC 16845, DBR Paper No. 788, 1977.

This paper discusses evacuation procedures in high-rise buildings and large public assembly buildings such as grandstands and arenas. Key findings from Canadian studies are presented, and some predictive models, using empirically derived relations, are illustrated.

Described are procedures for evacuation by stairs alone (total and selective evacuations) and by a combination of stairs and elevators (staged evacuation). In the latter case, movement is by stairway to a refuge floor, and then by express elevator to ground floor.

Also presented are some cautions regarding the setting up of fire safety plans in any occupancy:

- Don't overplan--the plan should state guidelines and principles rather than specifics. "...a massive disaster plan is no plan at all if no one knows what it says..."
- Plans should be tried out to uncover minor but crucial flaws.
- In holding drills, distinguish between the goal of training and education, and the goal of evaluation. In pre-announced drills take time to communicate general explanations in addition to specific directives. Other drills, unannounced, can be held to evaluate occupant preparedness, evacuation times, etc.

Index Words: Egress model; evacuation; fire drills; fire emergency planning; high-rise buildings; training and education.

107. Pauls, J.L. Movement of People in Building Evacuations. In: Human Response to Tall Buildings. Conway, D.J., Editor. Ch. 21, pp. 281-292. Stroudsburg, PA, Dowden, Hutchinson & Ross, Inc., 1977.

The author conducted observations between 1970 and 1974 of some 40 test evacuations of office buildings between 8 and 29 stories in height. A majority of these evacuations were total evacuations in

which all occupants attempted to leave the building more or less simultaneously by way of exit stairs. Presented are findings and interrelationships with regard to such variables as density and personal space, speed of descent, flow, stairway width and evacuation time. There were some observations of more selective procedures in which particular floors were cleared in a predetermined sequence starting with the presumed fire area.

Index Words: Evacuation; fire drills; high-rise buildings.

108. Pauls, J.L. and Jones, B.K. Building Evacuation: Research Methods and Case Studies. In: Fires and Human Behaviour, edited by David Canter, Chapter 13, pp. 227-249. New York, John Wiley & Sons, 1980. 338 pages.

Two case studies of large scale evacuation drills conducted without prior warning in government high-rise, office buildings in Ottawa, Canada are considered in detail. One case study involved the traditional total evacuation method; the other considered an early trial of the selective, sequential approach to evacuation of a building. The authors believe that there is enough similarity between conditions in these drills and those in a real emergency to make findings from these drills relevant to an understanding of actual emergencies. Participants in drills can be unsure of whether there is a real emergency or even conclude there is one when none exists (as was the case for some occupants in the selective evacuation case study). Hence, their behaviors can be considered representative of what might occur in some real emergencies. In one actual fire incident, in a building in which a drill had been observed earlier, the behavior of occupants as reported by evacuees and wardens was essentially the same as it had been observed in the drill.

The total evacuation drill conducted in "Building A" in October 1972 involved 1453 able-bodied persons using four perimeter exit stairs and 73 persons (those who were disabled, assistants, and some fire wardens) using the central stair. There were 14 typical office floors above ground level. Seventeen observers were used-- five at the exit discharges and twelve who moved with the evacuees. Observers were given detailed instructions and portable cassette recorders to record all observations during the drill. From these observations, data on speed of descent, density of people, and flow from the exit discharge points is graphically presented. An attempt by the building emergency plan to evenly distribute occupants to the four perimeter exits did not work out. Hence, the times measured for all evacuees (except stragglers separated from the main flow) to reach ground level at the various exits varied. The shortest time was 6.6 minutes; the longest, 9.3; and the average time was 7.8 minutes. The average time compared well with a predicted time

of 7.0 minutes. (See previous reference: Pauls, J.L., Building Evacuation: Research Findings ... for an account of the method used to predict evacuation time.)

"Building B," a 21 story office building was one of the first in Ottawa to have a selective, sequential evacuation procedure. With a large population and only two exit stairs, it would have required about 20 minutes to totally evacuate, an unacceptably long time. In selective evacuation, the fire floor is evacuated immediately. If conditions warrant it, the two floors immediately adjacent are evacuated next, then others, if necessary, starting from the top of the building. No extensive training in this new procedure was given to building occupants prior to this May 1971 drill. The drill was held without prior warning to all but a few occupants-- the chief fire warden and some assistants. There were both stationary and moving observers. Their observations plus the use of the public address and emergency telephone systems were recorded. In addition, 200 copies of a questionnaire were distributed, of which 176 were returned by people who had taken part in the evacuation. In the evacuation, there were 2006 persons using the stairs and approximately 70 disabled using the elevator. The observed evacuation time of 29.5 minutes can be compared with an adjusted prediction time of 26.6 minutes. This extra time used in the drill can partially be explained by the excessive and premature use of one of the two exits. Problems were encountered with the communications system, e.g., the initial public address system announcement was not carried due to an incorrectly set control, and the message when finally carried was ambiguous, not making it clear that only those on the third "fire" floor were to evacuate immediately. The problems encountered in this evacuation are not as likely to occur now in government-occupied office buildings in Ottawa since rigorous training programs and testing procedures have been introduced.

The authors recommend that, in this selective evacuation procedure, there be less centralized control. Instead of someone at the central control determining when the next floor in the sequence should begin evacuation, the warden of the floor where evacuation has been completed could directly inform the next floor in the sequence to evacuate. Central control personnel could monitor this activity and make public address announcements to floors where evacuation is to begin.

Index Words: Communications; evacuation; fire drills; fire emergency planning; handicapped; high-rise buildings; training and education.

109. Pauls, J.L. and Jones, B.K. Research in Human Behavior. Fire Journal, Vol. 74, No. 3, 35-41, May 1980.

This is a good overview of the research and literature to date in the field of human behavior in fire emergencies. The interest and effort in this field increased markedly in the 1970's following the publication of Wood's pioneer survey study on "The Behaviour of

People in Fires" in 1972. Research on human behavior related to fire, though increasing, still represents only a small percentage of the total fire research effort.

Major findings with regard to the various aspects of behavior in fires are discussed. Careless smoking habits and alcohol consumption greatly influence fire ignition and survival possibilities. People tend to do the familiar in fire emergencies - they take on familiar roles, they use familiar exits. Panic, in the sense of antisocial, aggressive, non-adaptive behavior is a rarity rather than the rule. Immediate well-organized evacuation appears to be the exception rather than the rule when people hear a fire alarm.

The authors emphasize the importance of regarding behavior in fires as a complex process, and point out specific areas in which failure to see this complexity can result in erroneous assumptions. They quote the definition of behavior in fire by Canter, Breaux, and Sime: "...behavior in fires can be understood as a 'logical' attempt to deal with a complex, rapidly changing situation in which minimal information for action is available." This contrasts with some earlier conceptions of people's responses to fire as being largely "instinctive" panic type reactions.

The close relationship between normal occupancy activities and emergency behavior has implications for design and management which need to be considered. For example, codes incorrectly credit exit capacity to stairs regardless of normal use despite the fact that an exit that is not normally used or not convenient will carry significantly fewer people in evacuations. Pauls' work (observing evacuation drills in Ottawa office buildings) exposed errors in the traditional 22 inch unit-exit-width basis for exit rules. He believes that "we should think of evacuation-time predictions--even those based on realistic, conservative flow assumptions--as minimums and not maximums, as is sometimes argued."

Index Words: Codes and standards; evacuation; literature review; overview - behavior in fire; panic.

110. Peterson, C.E. Geiger Nursing Home Fire. Fire Journal, Vol. 66, No. 1, 33-35, 38, January 1972.

The fire in the Geiger Nursing Home in Texas Township, Pennsylvania, on October 19, 1971, resulted in the deaths of all 15 of its elderly residents. All but one of the patients had been ambulatory. The fire originated in a clothes dryer in a utility room with no door on it. The one licensed practical nurse on duty was unable by shouting to arouse the patients, all of whom had been sedated for the night. Unsuccessful in her attempts to reach the fire department by telephoning from the nurses' station, she ran to the nearest residence, and the fire department was called from there. Although the fire department responded promptly, it was not in time to save any of the patients' lives.

Index Words: Fire fatalities; fire incident study; nursing homes.

110a. Peterson, C.E. 25 Die in "Boarding House" Fire. Fire Journal, Vol. 73, No. 6, 26-28, 30-33, 90, November 1979.

A fatal fire occurred on April 2, 1979, at the Wayside Inn, a licensed boarding house, near Farmington, Missouri. Twenty-five of the 37 residents were killed. The fire, probably electrical in origin, began sometime before 4:30 a.m. in the attic over the kitchen of this one-story, wood frame building.

The residents had ranged in age from 24 to 96 years of age. Some were deinstitutionalized mental patients, others were discharged veterans' hospital patients, and the remainder were individuals who chose to live at the Wayside Inn rather than maintain a separate residence for themselves. All of the residents were ambulatory, and certified as being able to care for themselves, needing only occasional personal services.

The licensure requirements for the facility stipulated that the facility must conform to the fire regulations of the location. However, in this case, no regulations were in effect because the facility was located in unincorporated county area, and there were no general state requirements.

It was concluded from this study of the fire that these three factors led to the large number of fatalities: 1) the undivided attic space through which the fire traveled in its initial stages, 2) the lack of a complete fire detection system with interconnected smoke detectors tied into the evacuation alarm, which would have given early notification of the fire, and 3) lack of fire emergency planning and training of staff and residents. Many of the residents were found in various states of dress, indicating they spent time trying to dress rather than immediately leaving the building.

Index Words: Boarding home; codes and standards; fire fatalities; fire incident study; smoke detectors; training and education.

111. Pezoldt, V.J. and Van Cott, H.P. Arousal from Sleep by Emergency Alarms: Implications from the Scientific Literature. National Bureau of Standards Interagency Report No. NBSIR-78-1484 (HEW). June 1978. Final Report. NTIS Order No. PB-284044.

This report reviews the sleep research and other literature pertaining to arousal from sleep by external auditory signals with emphasis on findings relevant for a nursing home population. Various factors which influence whether an alarm will produce arousal are considered. These include the intensity and other characteristics of the sound and the subject's age, sensory capacities, drug use, and stage of sleep as well as the time of night and meaningfulness of the sound for the subject. The problem of performance following abrupt arousal is also considered.

It is concluded that the currently available data do not provide an adequate basis for specifying the signal characteristics which will offer a high assurance of awakening a sleeping population. However, some generalizations can be made at this point which have value as hypotheses for future research efforts. For example, in some ways, older people may be considered easier to awaken than younger subjects due to the relatively lower proportion of their sleeping time spent in the stages of deep sleep and to the greater frequency of spontaneous arousals with increasing age. This presumed advantage may be offset by the impaired sensory functioning which also may accompany aging. Another finding is that stimuli which have personal meaning may produce arousal at lower levels of intensity than neutral stimuli. Further, previously neutral stimuli can obtain significance through learning or instruction.

Index Words: Alarms; literature review; nursing homes; training and education.

112. Phillips, A.W. The Effects of Smoke on Human Behavior--A Review of the Literature. Fire Journal, Vol. 72, No. 3, 69-71, 74-77, 122-123, May 1978.

This discussion of the effects of smoke on human behavior is broad in scope; it considers physical and physiological effects of smoke which can be expected to influence behavior, and presents anecdotal

and survey results regarding human behavior in fire.

The physical effects of both visible smoke (particulate matter) and invisible smoke (fire gases) are considered. Although there is considerable data on exposure to gases inhaled singly for prolonged exposures, there is a lack of data on the complex problem of the effect of fire gases in combination (a common fire situation) on the human body. While knowledge of the physical and physiological effects of gases in combination is poor, knowledge of the psychological and behavioral effects of exposure to combinations of gases is virtually nonexistent.

Described are the known physical effects of the various types of individual hazardous gases: pulmonary irritants, hypnotic, narcotic, and anesthetic gases; and "undetected killers" like carbon monoxide. Oxygen deprivation may cause fire victims to behave in an irrational manner.

How a person will respond in a smoke environment (provided the smoke is not totally disabling) depends on various factors such as familiarity with the building, training, past fire experience, and the presence of loved ones. Such factors are discussed in this article.

Data relevant to movement through smoke from P.G. Wood's comprehensive study of behavior in fires is given: People were willing to reenter buildings even in the presence of smoke; people tended to move through smoke farther when close members of the family were not present, etc.

Index Words: Evacuation; literature review; panic; smoke, influence of; toxic gases, influence of.

113. Pierman, B.C. and Lerner, N.D. Testing Symbols for Fire Situations. Fire Command, Vol. 47, No. 3, 12-13, March 1980.

The National Bureau of Standards has cooperated with the NFPA Firesafety Symbols Committee in the development and testing of standardized symbols for use in fire situations. Basically, two sets of symbols have been considered: (1) fire safety symbols for alerting building occupants regarding egress, fire fighting, and general fire safety, and (2) fire fighting symbols to aid fire fighters in locating and identifying equipment and utilities. The article describes the initial testing of proposed International Standards Organization (ISO) standards for fire safety symbols directed primarily at building occupants. The work of the NFPA Firesafety Symbols Committee in developing and testing symbols directed at firefighters (like those for identifying standpipe connections, automatic sprinkler control valves, and electric shutoff panels) is also described.

Index Words: Codes and standards; communications.

114. Predtechenskii, V.M. and Milinskii, A.I. Planning for Foot Traffic Flow in Buildings. Moscow, Stroiizdat Publishers, 1969. Translated from Russian. Published for the National Bureau of Standards, U.S. Department of Commerce, and the National Science Foundation, Washington, D.C. by Amerind Publishing Co. Pvt. Ltd., New Delhi, 1978. 240 pp.

This is a highly technical book on research done in the Soviet Union on movement of people in public buildings.

"During the last 30 years, experimental and theoretical studies on the movement of people in public buildings have been conducted in the Soviet Union...This research revealed certain patterns governing the flow of people and led to an understanding of the basic principles involved. The results gave architects and builders entirely new requirements for the standardization calculation and selection of optimum architectural designs for public buildings with considerable foot traffic...This book presents the methodology and results of experimental and theoretical study of the movement of people, the fundamentals of the theory and the calculation of the process, as well as practical recommendations for incorporating the findings in the planning and design of public buildings."*

*excerpted from the book's preface

Index Words: Evacuation; experimental studies.

115. Quarantelli, E.L. Five Papers from a Panel Session on Panic. In: Second International Seminar on Human Behavior in Fire Emergencies, October 29 - November 1, 1978 -- Proceedings of Seminar, p. 203. National Bureau of Standards Report No. NBSIR 80-2070. Issued June 1980. NTIS Order No. PB 80 204738.

E.L. Quarantelli of the Ohio State University Disaster Research Center chaired a panel on "panic" at an international seminar on human behavior in fire emergencies. The five panelists were asked by Mr. Quarantelli to reply in their individual presentations to these questions:

- 1) Do you see the concept of panic as a useful one for study purposes?
- 2) How do you conceptualize panic and what are the factors responsible for the phenomena?
- 3) What are both the research consequences and practical implications of thinking about panic in the way you do?

The panelists were: Corinne Black of Princeton University, John Bryan of the University of Maryland, A.R. Mawson of Loyola University in New Orleans, Jonathon Sime of the University of Surrey, England,

and Dennis Wenger of the University of Delaware.

For summaries of the panelists remarks see references:

- Black, C.M. Panic: Some Anthropological Insights...
Bryan, J.L. Panic or Non-Adaptive Behavior in the Fire Incident...
Mawson, A.R. Is the Concept of Panic Useful for Scientific Purposes?...
Sime, J.D. The Concept of 'Panic in Fires': A Brief Appraisal...
Wenger, D. Some Observations on the Nature of Panic Behavior:
A Normative Orientation...

Index Word: Panic.

116. Quarantelli, E.L. Panic Behavior: Some Empirical Observations. In: Human Response to Tall Buildings. Conway, D.J., Editor. Ch. 27, pp. 336-349. Stroudsburg, PA, Dowden, Hutchinson & Ross, Inc., 1977.

The common view is that people will react irrationally in extreme stress situations. Examples of official "inaction" based on this belief are detailed. Based on research done since early 1950's at the Ohio State University Disaster Research Center (author's location) and at other centers throughout the world, there is general consensus among researchers that the common view is false and that behavior under extreme stress is relatively controlled and rational.

A definition of panic as an acute fear reaction marked by flight behavior is expanded upon. Covert and overt features are identified. Described are conditions for panic such as: perception of possible entrapment, sense of powerlessness, and feeling of sole dependency upon oneself in a crisis.

Index Word: Panic.

117. Ramey-Smith, A.M. and Fechter, J.V. Group Homes for the Developmentally Disabled: Case Histories of Demographics, Household Activities, and Room Use. National Bureau of Standards Report No. NBSIR 79-1727. Final Report. October 1978. Issued April 1979. NTIS Order No. PB 295037.

The objective of this study was to provide data useful for the development of fire/life safety requirements appropriate for group homes for the developmentally disabled. Nine geographically dispersed group homes, housing between 5 and 40 residents, were included in the study.

Survey techniques were used to compile summary data on residents' room use and activities, characteristics of the group home facilities, and demographics of the supervisors and residents. The data for

room use and activities of developmentally disabled residents are compared to results available for the normal population. It was concluded that residents of group homes and residents of normal households do not differ appreciably in their use of rooms within the respective households, and that the developmentally disabled engage in the same general types of activities as the normal population.

Data are also presented on evacuation times in fire drills held at the group homes. In all cases the evacuation times were less than three minutes. The authors conclude that education and practice in fire evacuation is essential and should involve experience with multiple escape routes, blocked exits, and meeting at an assigned area outside the facility. However, a point of diminishing returns may be reached when fire drills are held too frequently, with residents becoming desensitized to the necessity of immediate evacuation.

Index Words: Boarding homes; evacuation; fire drills; handicapped; training and education.

118. Rubin, A.I. and Cohen, A. Occupant Behavior in Building Fires. National Bureau of Standards Report No. TN-818. Issued February 1974. U.S. Government Printing Office, Washington, D.C. SD Catalog No. C13.46.818.

This is an overview of the problem of fire safety in high-rise buildings, with emphasis on the need to develop fire safety systems which are genuinely responsive to occupants' needs and realistically reflect human capabilities and liabilities. There is a discussion of the value of a "performance" approach to fire safety with its use of system analysis to overcome the constraints inherent in a "prescriptive" approach which tends to stifle innovative solutions. Some literature specific to behavior of people in fires is reviewed as well as some background literature on behavior under stress or in disasters in general. The findings of the Airlie House Conference on Fire Safety in High-Rise Buildings (April 1971) on design/management problems are reviewed.

Index Words: Fire emergency planning; high-rise buildings; literature review.

119. Scanlon, Joseph Human Behavior in a Fatal Apartment Fire--Research Problems and Findings. Fire Journal, Vol. 73, No. 3, 76-79, 122-123, May 1979.

A study of the Fort Garry Court apartment fire which occurred on February 21, 1976 in Winnipeg, Manitoba, Canada, and which resulted in 5 fatalities (ages 60-90) was done by the Emergency Communications Research Unit (ECRU) at Carleton University as part of a continuous study of behavior in response to unexpected events.

This article describes the special problems encountered and methods used in locating those persons who were in the building at the time of the fire. Checking techniques were used to try to verify the accounts of those who were found and interviewed: i.e., occupants' accounts were compared to firemen's accounts and accounts were checked against the physical layout of the building (difficult because of the irrational layout of the building).

Some findings and conclusions were: false alarms may condition people to reject the alarm alone as a meaningful warning--often people went to look for confirming evidence of a fire; many left slowly--females more so than males; people did re-enter to get possessions after reaching safety even after having seen smoke and flames while outside in the courtyard; and those who had left immediately were most likely to go back in after being outside. ECRU's findings in this study are compared and sometimes contrasted with those of other researchers (Wood, Bickman, Bryan) in work done elsewhere.

Index Words: Alarms; fire fatalities; fire incident study; residential occupancies.

120. Sears, Jr., A.B. Nursing Home Fire. Fire Journal, Vol. 64, No. 3, 5-9, May 1970.

This is an account of a disastrous fire in a modern one-story nursing home built almost entirely of noncombustible materials. The fire in the Harmar House Convalescent Home in Marietta, Ohio on January 9, 1970 resulted in the deaths of 31 out of the 46 patients, with smoke inhalation being listed as the cause of most of the deaths.

The fire originated in a wastebasket in a patient room and was detected through the activation of the heat detection system which sounded an alarm at the nurses' station. There was, however, no direct connection from the detection system to the Fire Department, and there was a delay in alerting the Fire Department. Staff removed the patient from the room of fire origin but neglected to close the door behind them. Flames spread rapidly down the hallway. There were no smokestop partitions in the corridors of the building to prevent the spread of smoke to the other corridors of the building. Many of the 21 who died during the fire were sleeping in rooms with the doors left open. Two patients who were sleeping in a room with the door closed just two rooms away from the room of fire origin survived.

See the following entry in this bibliography for an account of modifications made in this nursing home when remodeled after the

fire in an effort to prevent future tragedies.

Index Words: Fire fatalities; fire incident study; nursing home.

121. Sears, Jr., A.B. Nursing Home Fire Follow-Up. Fire Journal, Vol. 65, No. 2, 37-39, March 1971.

Described are the modifications made in the Harmar House Convalescent Home in Marietta, Ohio after the fire on January 9, 1970 which took the lives of 31 elderly patients. Three sets of smokestop doors were added, separating each of the three patient room wings from the center section. They close automatically if a detector or sprinkler operates. The previous heat detection system was replaced by a combination heat and smoke detection system in order to give earlier warning of fires that generate smoke but not much heat during the early stages. An automatic sprinkler system, protecting the entire building including closets and lavatory facilities in patient rooms, was installed. The rubber-backed nylon floor covering which was the principal source of smoke in the fatal fire was replaced with non-rubber-backed nylon.

Index Words: Fire fatalities; fire incident study; nursing home; smoke detectors; sprinklers.

122. Seeger, P.G. and John, R. Evacuation Tests in High-Rise Office Buildings and in Large 2-Story Buildings. In: Second International Seminar on Human Behavior in Fire Emergencies, October 29 - November 1, 1978 -- Proceedings of Seminar, pp. 221-247. National Bureau of Standards Report No. NBSIR 80-2070. Issued June 1980. NTIS Order No. PB 80-204738.

This study reports on evacuation tests carried out in three high-rise administration buildings and three large-area integrated schools in cooperation with the professional fire brigades in Köln, Düsseldorf and Hamburg in October 1976. Video cameras were used to record the movement flows of people. From these video records, the factors of density of people and rate of flow of people were determined. In the evacuation tests in the three administration buildings, only the flow of people on staircases was studied, while in the three integrated schools, the flow of people in corridors was investigated. Data showing rate of flow of people as a function of density of people for the various test settings are presented graphically.

Values for evacuation times found in these evacuation tests are compared with the results predicted by three theoretical calculation methods. The calculated values, using all three methods, were below the measured values. This can partly be explained by the fact that none of the calculation methods allows for a delay time between the time of the alarm sounding and the beginning of the evacuation. However, if an allowance for reaction time is added to

the values calculated using the methods of Predtetschenski et al and Muller, then the resultant values are in close agreement with the real evacuation times obtained during the evacuation tests in the three administration buildings.*

*Annotation is authors' abstract.

Index Words: Egress model; evacuation; fire drills; high-rise buildings; schools.

123. Sharry, J.A. Another Pennsylvania Nursing Home Fire. *Fire Journal*, Vol. 68, No. 3, 11-14, May 1974.

The fire in the Caley Nursing and Rehabilitation Center in Wayne, Pennsylvania on December 4, 1973 took the lives of 15 out of the 96 patients. It originated in a clothes closet in a patient room in an old section of the facility and was detected by a nonambulatory occupant who alerted her roommate. The roommate walked to the nurses' station to report the fire. The initial evacuation was by two maintenance men who carried out patients until the fire became so intense it caused flashover into the lobby. Two patients in the fire area could not be reached by firefighters before extinguishment and were found dead.

The remaining 13 of the 15 fatalities were victims of smoke inhalation and occupied the new wings which were not directly involved in the fire. There was a lack of smokestop doors in the wall separating the new and old sections of the building, and this departure from the NFPA 1967 Life Safety Code appears to have been the most critical in contributing to the large loss of life.

Index Words: Codes and standards; fire fatalities; fire incident study; nursing home.

124. Shavit, G. Evacuation: Testing the Effect of Voice-Message Formats. *ASHRAE Journal*, 38-41, July 1978.

The article is concerned with the alarm function in fire management in high-rise buildings. The author is Chairman of Advanced Engineering, Honeywell, Inc. Arlington Heights, IL. The research work was done with the Department of Psychology at the University of Illinois.

A set of experiments was conducted to determine the most effective attention-getting signals. Eight different stimuli were selected and used in three different experimental settings to study responses to the signals under different levels of a participant's involvement with his surroundings and the ambient noise levels. An alarm beeping sound was found to be the optimal alerting signal.

Other experiments were designed to identify desirable characteristics of accompanying voice messages. Factors such as brevity, identification of authority figure, and clarity were considered. It was found that latency of response correlated quite highly with message length, which suggests the need to keep the message brief so that occupants can and will act sooner. Results showed that less than half of the meaningful bits of information were recalled. It was found that persons just as readily followed instructions to move up to safety as to move down.

Index Words: Alarms; communications; experimental studies; high-rise buildings.

125. Sime, J.D. The Concept of 'Panic.' In: Fires and Human Behaviour, edited by David Canter, Chapter 5, pp. 63-81. New York, John Wiley & Sons, 1980. 338 pages.

This is a discussion of the widespread, often misleading, use of the term "panic" in the newspapers, in building regulations and the design literature, and in the academic literature, to describe the typical human response to a fire situation. The term panic has been used to mean the highly emotional, automatic response to noxious stimuli such as smoke and flames, usually in the form of irrational, disorganized flight behavior. The author feels that this oversimplification of human responses to a fire situation has been harmful in that it has replaced a more systematic psychological appraisal of the full range of behaviors of people in fires.

Newspaper accounts tend to regard an unfavorable outcome of a fire as automatic evidence that "panic" occurred and produced the outcome. The British press attributed the deaths in the Beverly Hills Supper Club fire in Kentucky (1977) to panic; in contrast, a well-researched National Fire Protection Association (U.S.) report attributed the deaths to other human factors (delay in notification of the occupants) as well as to building factors. In French and British design and regulatory literature, panic is regarded as the major psychological factor contributing to disasters. This assumption has led to strategies in which provision of information to the general public regarding a fire is delayed or minimized. An example of such a strategy is the dual alarm system in department stores in Britain, in which an alarm sounds first in the staff area. Delay in notification can have harmful consequences, as in the Beverly Hills fire and the Summerland fire, Isle of Man (1973).

In a general discussion of the concept of panic, the author strongly objects to the tendency to label all flight behavior as panic, especially when rapid, somewhat disorganized flight may be the only rational option, and he objects to the failure to take into account the individual's limited perspectives and knowledge in a fire. It is inappropriate to label a person's behavior as irrational for not

using an alternate available exit, if the person has not been previously made aware of the existence of this exit.

Index Words: Alarms; codes and standards; fire incident study; panic.

126. Sime, J.D. The Concept of 'Panic in Fires': A Brief Appraisal. In: Second International Seminar on Human Behavior in Fire Emergencies, October 29 - November 1, 1978 -- Proceedings of Seminar, pp. 211-214. National Bureau of Standards Report No. NBSIR 80-2070. Issued June 1980. NTIS Order No. PB 80 204738.

The author argues that rather than considering panic as a definable phenomenon that can be readily measured, more attention should be directed to the way the concept is used. The concept figures prominently as a justification for certain fire safety measures. It is also used retrospectively to explain apparently inappropriate behavior in fires. Basic weaknesses in the way the concept is used are considered, in particular the differing perspectives of fire victim and observer of the outcome of a fire tragedy. Confusions also arise because the evidence for panic is usually based on "external criteria" which define the most efficient pattern of behavior in the situation. Behavior should be assessed against "internal criteria," that is, the alternative courses of action which individuals could have been aware of at the time of their involvement in a fire. The most important practical implication of the way the concept has been used concerns the information people in a public building on fire are given about the potential danger. Research shows that people need sufficient information about a fire before they can or are prepared to leave a building. An emphasis on avoiding "panic" contributes to delays in providing this information. The kind of rapid flight behaviour associated retrospectively with panic then becomes necessary if people are to have any chance of escape.*

*Annotation is based on the author's abstract with modifications and additions.

See also reference: Quarantelli, E.L. Five Papers...

Index Word: Panic.

127. Stahl, Fred I. BFIREs/Version 2: Documentation of Program Modifications. National Bureau of Standards Report No. NBSIR 80-1982. March 1980. NTIS Order No. PB 80-169949.

This report documents recent modifications to BFIREs, a computer program designed to simulate the emergency egress behavior of building occupants during fires.

Discussed are several limitations to the use of the previous BFIRES/VERSION 1. (See Stahl, F.I. NBSIR 79-1713, Final Report on the "BFIRES/VERSION 1" Computer Simulation of Emergency Egress Behavior During Fires: Calibration and Analysis.) Chief among these are the program's inability to simulate rescue activities during fire events, and to simulate direct interactions between occupant behavior and toxic qualities of smoke-filled environments. This report documents a revised program, BFIRES/VERSION 2, which contains new subroutines developed to address these problems. These subroutines are grouped into two modules: (1) a "smoke" module designed to simulate the experience of inhabiting a smoke filled environment, and (2) a "rescue" module intended to permit the rescue of physically immobile occupants.

This report is meant as a companion to the earlier publication. As a convenience to the reader, however, a complete FORTRAN listing of BFIRES is provided in the appendix.*

*Annotation is based on author's abstract with additions.

Index Words: Computer model; egress model; handicapped.

128. Stahl, F.I. A Computer Simulation of Human Behavior in Building Fires: Interim Report. National Bureau of Standards Report No. NBSIR 78-1514. Issued September 1978. March 13, 1978. NTIS Order No. PB-289 272.

This interim report presents the conceptual development, structure, and function of BFIRES, a computer program designed to simulate human movement behavior during building fires. It can aid in the prediction of escape times and escape routes of building occupants during fires.

The basic model underlying BFIRES is derived from a non-stationary, discrete time Markov Process. This model postulates that occupants construct their emergency responses and behavioral decisions dynamically, in response to continually changing social and environmental information fields. The simulation of this process is accomplished through the BFIRES computer program written in FORTRAN V. The report contains the flow diagrams for the executive program and the various subroutines as well as the FORTRAN V listing of the program.*

*Annotation is based on the author's abstract with additions.

Index Words: Computer model; egress model.

129. Stahl, F.I. Final Report on the "BFIRES/Version 1" Computer Simulation of Emergency Egress Behavior During Fires: Calibration and Analysis. National Bureau of Standards Interagency Report No. NBSIR 79-1713. October 15, 1978. Issued March 1979. Final Report. NTIS Order No. PB-295063.

This report is the product of an effort to develop and analyze a computer simulation of human egress behavior during fires. It documents computer simulation experiments designed to calibrate and analyze this computer program (BFIRES/Version 1).

The findings concerning the calibration and sensitivity of BFIRES are discussed. In particular, it is shown that: (a) a variety of general egress situations may be simulated through the application of BFIRES; (b) every such event is unique, and is defined by the set of user-supplied input parameter values which describe the building, the threat, and the occupants; (c) BFIRES may be used in simulated environments of known (or desired) spatial dimension, and events of known (or desired) temporal duration; and (d) BFIRES simulation outcomes are sensitive to variations in a number of parameters of immediate interest to the building design and regulatory communities.*

*Annotation is based on author's abstract.

Index Words: Computer model; egress model.

130. Stahl, F.I. Human Response to Fire: Three Designs for Research. National Bureau of Standards Interagency Report No. NBSIR 78-1508. March 1978. Interim Report. NTIS Order No. PB-284959.

The author feels that there is a need for more rigorous experimental designs in studies of occupant response to fires. He accordingly developed three sample research designs, utilizing both exploratory and field experimental approaches.

The role of the experience survey and structured interview as exploratory approaches which may serve to identify hypotheses for further more focused studies is discussed.

Two possible field-experimental designs are detailed. One would analyze building occupants' predispositions for various responses in fire emergencies and consider factors such as sex, functional role, location within a building, and context, i.e., at home vs. at work. (An individual's predispositions for response to an emergency could vary with different contexts.)

A second field-experimental design would relate to the general question of the effectiveness of pre-emergency training in promoting

appropriate behaviors during actual fire emergencies. In particular, the effect of general vs. "building specific" (which would consider the problem of life safety in the occupants' own building) training programs on occupants' egress knowledge for buildings of simple and of complex physical layout and design might be tested.

Index Words: Experimental studies; training and education.

131. Stahl, F.I. Preliminary Findings Concerning the Validity of "BFIRES": A Comparison of Simulated with Actual Fire Events. In: Second International Seminar on Human Behavior in Fire Emergencies, October 29-November 1, 1978 -- Proceedings of Seminar, pp. 249-258. National Bureau of Standards Report No. NBSIR 80-2070. Issued June 1980. NTIS Order No. PB 80-204738.

This report presents preliminary findings regarding the validity of BFIRES/ VERSION 1, a computer program developed at the National Bureau of Standards to simulate egress movement by building occupants during fires. A computer simulation experiment was conducted in order to compare outcomes from BFIRES runs with data selected from an archival file summarizing actual fire results. Findings from this experiment suggest that BFIRES is capable of reproducing such important fire outcomes as loss-of-life and numbers of persons ultimately escaping. In addition, patterns of egress behavior produced by BFIRES were compared with those found in the literature, with professional opinions, and with impressions gathered from anecdotal accounts. With few exceptions, these comparisons illustrate agreement between simulations and other data sources.*

*Annotation is author's abstract.

Index Words: Computer model; egress model; fire incident statistics.

132. Stahl, F.I. Simulating Human Behavior in High-Rise Building Fires: Modeling Occupant Movement Through a Fire-Floor from Initial Alert to Safe Egress. National Bureau of Standards Report No. NBS-GCR-77-92. Issued August 1977. June 26, 1975. NTIS Order No. PB-273-166.

There are difficulties involved in the use of field experimentation for testing hypotheses about emergency behaviors. These include the relative infrequency and irregularity with which building fires occur and questions of the validity and reliability of the data obtained from participants. This report explores an alternative approach, the use of simulation modeling techniques, through which to predict emergency behaviors and describe building fire systems. Simulation models allow the examination of the life safety potential of building designs while these are still on the drawing board.

One section of the report describes previous research involving simulation of human movement behavior in a spatial field. The major portion of the report presents the statement of a loosely structured hypothetical model of human behavior in a high-rise building fire, a description of the main routine of this dynamic model and the various subroutines, and prospects for its use. The model would operate within the boundaries of a single floor in a high-rise office building. It would permit simulation of individual or group decision-making in a spatial field containing information about an advancing fire threat and in response to sudden interruptions to goal-directed behavior.

Index Words: Computer model; egress model; high-rise building.

133. Stahl, F.I. and Archea, J. An Assessment of the Technical Literature on Emergency Egress from Buildings. National Bureau of Standards Report No. NBSIR 77-1313. October 1977. NTIS Order No. PB-273944.

This literature search was conducted to determine the extent to which current standards for emergency egress in facilities regulated by the Occupational Safety and Health Administration (OSHA) were based on empirical research, and to determine the adequacy of available research findings from which OSHA emergency egress regulations may be developed.

Three areas of research on emergency egress were identified: (1) the carrying capacity of exitways, (2) signage, lighting, and visibility through smoke, and (3) occupant responses to, and experiences in building fires. The report analyzes and shows the historical development of two different approaches to egress research--the initial physical science "carrying capacity" school and the "human response" school of research. The former approach assumes occupants respond immediately to the emergency (like water or gas particles) and are affected only by spatial configuration and density during the actual evacuation process. The latter approach also considers the influence on evacuation time of such human factors as decision-making in an ambiguous situation or organizational factors such as the presence of trained supervisors or communications systems.

The problems inherent in the various methodologies for studying egress (field based quasi-experimental research designs, post-hoc survey and laboratory designs) are assessed.

The author concludes that only research on the carrying capacity of exitways appears to have had direct impact on current OSHA regulations, which are based largely on empirical findings reported in 1935. A table analyzing various OSHA regulations with reference to the available data base and providing recommendations for future research is contained in the report.

Index Words: Codes and standards; communications; evacuation; literature review.

- 133a. Stahl, F.I., Crosson, J.J. and Margulis, S.T. Time-Based Capabilities of Occupants to Escape Fires in Public Buildings: A Review of Code Provisions and the Technical Literature. In press.

This report reviews both the available technical research pertaining to exit facility design and the emergency escape provisions of the National Fire Protection Association's Life Safety Code (1976 Edition), in order to determine the technical support for such provisions. The report focuses on the time-based capabilities of building occupants to effect rapid evacuations, in relation to evacuation time available during fires. A number of functional criteria (e.g., maximum travel distance, building configuration, and barriers to egress flow) are examined in relation to Code provisions which influence the design of means of egress and fire protection and protective signalling systems for places of assembly, residential occupancies, mercantile occupancies, and business occupancies. Provisions affecting fire exit drill and building management practices are also considered.

This report organizes Code provisions and related technical discussions under these areas of potential impact: pre-emergency training and preparation, perception of the emergency environment and recognition of egress facilities, egress strategy formation, disciplined egress behavior and crowd movement, occupants' capabilities to safely and rapidly negotiate egress ways, and the capacity of means of egress. Within each section of the report, provisions of the Code which have a common area of potential impact, and human behavioral assumptions underlying these provisions, are enumerated. The technical literature bearing on these provisions and assumptions is also presented. The validity and generalizability of the findings in this literature is discussed, and the degree of technical support currently available for egress provisions of the Code is evaluated.

Preliminary conclusions about the supportability of Code provisions are presented. Where technical support for human behavioral assumptions underlying these provisions is either weak or unattainable, the authors do not recommend eliminating or otherwise modifying these provisions. Rather, in such instances it is suggested that further technical investigations be conducted.*

*Annotation is derived closely from the authors' abstract and executive summary.

Index Words: Alarms; codes and standards; evacuation; fire drills; fire emergency planning; literature review; training and education.

134. Stevens, R.E. Behavior and Protection of People in Fire Emergencies. In: International Fire Protection Seminar, 5th. Vol. 2, 13-21. Sponsored by the Vereinigung zur Forderung des Deutschen Brandschutzes e.V. Karlsruhe, West Germany, September 22-24, 1976.

This paper discusses characteristics and behavior patterns of people that are relevant to fire safe design. Described are: special problems encountered in nursing homes, characteristics of a good fire safety educational program, and the behavior of occupants in several case study fires. A brief history of the development of the National Fire Protection Association Life Safety Code, NFPA 101, is given. The author outlines some code requirements that are predicated upon human behavior in fire emergencies as shown by case histories. He recommends, for future research, studies of the behavior of those with special responsibilities in a fire situation and of the methods by which people can be motivated to be aware of fire danger and to react to it rationally.

Index Words: Codes and standards; fire incident study; nursing homes; training and education.

- 134a. Stewart, R.D., Peterson, J.E., Fisher, T.N., Hosko, M.J., Baretta, E.D., Dodd, H.C. and Herrmann, A.A. Experimental Human Exposure to High Concentrations of Carbon Monoxide. Arch Environ Health, Vol. 26, 1-7, January 1973.

The results of an experimental study on human exposure to high concentrations of carbon monoxide are given. The main objective of the study was to determine the rate of CO absorption during brief exposures to the gas in the concentrations found in automobile exhaust and in burning buildings, concentrations not previously studied in human volunteers. The experimenters also wished to observe any change in normal physiological status that might occur during these experiments. Two of the subjects experienced an abrupt onset of mild frontal headache immediately following their exposures to these high concentrations of CO.

A technical description of this experiment is as follows: "Six healthy male human volunteers were exposed to seven high carbon monoxide (CO) concentrations ranging from 1000 ppm for ten minutes to 35,600 ppm for 45 seconds. Carbon monoxide was rapidly absorbed and the increase in percent carboxyhemoglobin (COHb) saturation in venous blood per liter of CO mixture inhaled could be accurately predicted by the equation, $\log (\Delta \% \text{ carboxyhemoglobin/liter}) = 1.036 \log (\text{ppm CO inhaled}) - 4.4793$. The abrupt increase in carboxyhemoglobin concentration of 11.6% and 9.1% saturation in two subjects produced the immediate onset of mild frontal headache. The subject exposed to 35,600 ppm demonstrated slight sagging of the ST-segment of lead II. This occurred 20 seconds after the exposure had started and persisted for ten minutes after exposure. Neither the spontaneous nor the evoked electrical activity of the brain exhibited significant changes which could be attributed to CO exposure over the range studied."

Index Words: Experimental study; toxic gases, influence of.

135. Strother, R.R. and Buchbinder, L.B. Communications Strategies for Fire Loss Reduction. In: Fires and Human Behaviour, edited by David Canter, Chapter 17, pp. 315-321. New York, John Wiley & Sons, 1980. 338 pages.

Strategies being used by the U.S. Fire Administration (USFA) to achieve fire loss reduction within communities through educational programs are described. The Office of Planning and Education (OPE) identified and studied fire education programs which had been successful in the past in reducing fire losses. Two major factors associated with success were found to be: the targeting of education programs at specific local fire problems and community involvement in program development and implementation. These factors were illustrated in the successful program in 1973 in Beauregard Parish, Louisiana, by the U.S. Forest Service and Louisiana State University, to reduce intentional burning of woods in rural areas. Influential local opinion leaders were used to reinforce mass media education messages regarding the setting of fires.

A National Fire Protection Association (NFPA) study in 1975 led to the conclusion that fire prevention messages must be explicit and must show the desired behavior in the context where the action should occur. People's apparent apathy to fire prevention messages, despite their strong fear and concern about fire, can result from feelings of inability to cope with vague and complex fire safety procedures.

The Public Education Assistance Program (PEAP), developed by OPE, to implement successful education strategies is described. PEAP assists states by providing administrative guidance, fire education resource materials, and by providing technical guidance in planning, implementing, and evaluating public education programs to the communities within their jurisdiction.

Index Words: Firesetters; training and education.

136. Strother-Smith, N.C. A Study of the Behavior of People in Fires. Fire Prevention, No. 121, 16-24, October 1977.

This article details numerous case histories illustrating a wide range of both inappropriate and appropriate behavior of people in fires. It summarizes findings of the survey conducted in 1972 by P.G. Wood of the British Research Station. It describes a 2-stage alarm system designed primarily for department stores as an alternative to one general alarm which may either cause panic or be ignored. Two large fatality fires--the Brussels department store fire in 1968 and the Joelma building fire, Sao Paulo in 1974--in which panic behavior occurred are described. The author's main conclusion is that the behavior of people in fires is unpredictable, but he nevertheless feels that proper training could increase coping skills.

Index Words: Alarms; fire fatalities; fire incident study; panic; training and education.

137. Swartz, J.A. Human Behavior in the Beverly Hills Fire. Fire Journal, Vol. 73, No. 3, 73-74, 108, May 1979.

This study of the fire at the Beverly Hills Club in Southgate, Kentucky, on May 28, 1977, which resulted in 165 deaths, analyzes the human behavior aspects of the emergency and, in particular, considers the impact of "role assumption" on fire emergency conduct. Information was obtained from questionnaires and taped interviews of building occupants, key staff personnel, and fire officers who responded to the emergency.

It was found that the people involved continued to fulfill the roles they assumed prior to the fire. Staff consistently took actions to assist patrons, whereas patrons followed or took a more passive role. Staff members took care of the patrons which they would normally serve. Thus firesafety plans for public places should not prescribe emergency actions that are contrary to people's normal roles.

The author concludes that occupants of the Club felt safe not only before but after being notified of the fire and provides reasons for their feelings and for the underestimation of the severity of the fire by both staff and patrons. There was a false sense of

security felt by the fact that the Cabaret Room where most of the patrons were was a long way from the room of fire origin. Hence fire safety education should consider people's erroneous conceptions of distance being related to safety and the time to escape.

Panic seems not to have occurred, at least in the antisocial, destructive sense of the word.

Index Words: Fire emergency planning; fire fatalities; fire incident study; panic; training and education.

138. Van Bogaert, A.F. Fire Prevention in Schools and Boarding Schools for Handicapped. In: Second International Seminar on Human Behavior in Fire Emergencies, October 29 - November 1, 1978--Proceedings of Seminar, pp. 261-277. National Bureau of Standards Report No. NBSIR 80-2070. Issued June 1980. NTIS Order No. PB 80-204738.

This study was designed to assist in developing new safety requirements for schools and boarding schools for handicapped children and adolescents. Existing requirements did not satisfy the Belgian School Building Fund (SBF).

The deficiencies of the handicapped fall into the areas of perception, response, and mobility. Four categories of disabled--children with mental handicaps or with emotional disturbance, children with physical handicaps only, children with auditive deficiencies, and children with visual deficiencies-- are described in terms of these areas, and recommendations are made with regard to building design, construction, equipment and staffing. Under existing classifications of the handicapped, children who are both bodily and mentally handicapped are classified according to their mental impairments. Hence the SBF organized an investigation (December 1977) to get information on the number of pupils in mentally handicapped groupings who also had mobility problems. Data are given for schools and boarding schools on percentage of nonambulatory among mentally, emotionally, or functionally handicapped students and on the percentage of nonambulatory among the physically handicapped.

This paper considers the problem of evacuation in schools for the handicapped. It describes a hypothetical egress pattern for schools for mentally or physically handicapped housing a mixture of ambulatory and nonambulatory students; discusses existing and desirable personnel/pupil ratios; gives data on two nighttime fire drills from special boarding schools; discusses limited versus complete evacuation, and recommends those building levels on which children with various types of handicaps might be placed.*

*Annotation is author's abstract.

Index Words: Evacuation; fire drills; handicapped; schools.

139. Vreeland, R.G. and Levin, B.M. Psychological Aspects of Firesetting. In: Fires and Human Behaviour, edited by David Canter, Chapter 3, pp. 31-46. New York, John Wiley & Sons, 1980. 338 pages.

This chapter presents findings from an extensive search of the relevant literature regarding the motives of firesetters, the etiology of this behavior, and the treatment of firesetting. Categories of firesetters are defined and described, and there is an attempt to extract a picture of a "typical firesetter." Many of the conclusions in this chapter are drawn from the classic study by Lewis and Yarnell (1951) which covered a large sample of over 1300 cases and a wide range of types of firesetters.

Levin has identified three major groups of firesetters: arson-for-profit firesetters, solitary firesetters, and group firesetters. There is little in the psychological literature about the first group, which would include the business man who sets fire to his own business to collect the insurance, presumably because this type of act might be considered "rational." The solitary firesetters (excluding those with a profit motive) who set fires in secret are the group most widely studied by researchers. This group includes "pyromaniacs" who set fires simply because of an "irresistible impulse" and "would be hero" firesetters who start fires and help firefighters put them out. Groups set fires for political purposes, to vandalize, and in the course of riots.

The "typical" firesetter exhibits many maladaptive behaviors in addition to firesetting. He has experienced a great deal of failure in social activities, and, if he chooses to engage in aggressive behavior, he will avoid direct confrontation with the victim. The similarities between malicious firesetters and other criminals are more striking than the differences. However, the authors tentatively suggest that arsonists may be more prone to commit crimes against property, not counting the firesetting, than other criminals.

Index Words: Firesetters; literature review.

140. Vreeland, R.G. and Waller, M.B. Personality Theory and Firesetting: an Elaboration of a Psychological Model. University of North Carolina, Chapel Hill. National Bureau of Standards Report No. NBS-GCR-80-194. December 1979. Issued February 1980. NTIS Order No. PB 80-161599.

This report is designed to place what is known about firesetting within the broad context of current knowledge of personality and behavior. It is more technical in nature and its target audience is narrower than an earlier companion report. (See reference: Vreeland, R.G. and Waller, M.B. The Psychology of Firesetting...) This report is aimed at behavioral scientists and clinicians who

are interested in understanding and treating deviant firesetting behavior.

Social learning theory was chosen as the theoretical framework for understanding the development of firesetting behavior. Three types of interactions between a person and his environment are considered: (1) the person acts upon and is acted upon by the environment (behavioral processes), (2) modelling and instructional influences are received (vicarious processes), and (3) the person selects, encodes, and evaluates incoming information about the social environment (cognitive processes). These basic components of a person's adaptation to the environment sometimes interact in ways which produce and maintain deviant behaviors such as firesetting. Implications derived from social learning theory for treatment of firesetting in children and adults are described.

Index Words: Conceptual model; firesetters; literature review.

141. Vreeland, R.G. and Waller, M.B. The Psychology of Firesetting: A Review and Appraisal. University of North Carolina, Chapel Hill. National Bureau of Standards Report No. NBS-GCR-79-157. January 1979. 38 pp. NTIS Order No. PB-290821.

This report reviews the literature on firesetting and presents a new approach for categorizing firesetters. Relatively little is known about the determinants of firesetting, partly because of the barriers to carrying out systematic, well-controlled research. Various legal problems and the fact that relatively few arsonists are apprehended make it likely that research samples will be narrow and biased.

Firesetters have often been typed in terms of their motive for the act (insurance fraud, revenge, etc.) or simply according to a characteristic of the sample being studied (sex, age, etc.). The authors present a new classification approach which involves a consideration of four major factors: antecedent environmental conditions, organismic variables (i.e., such personal variables as sex, age, genetic factors), actual firesetting behavior, and the consequences of firesetting. "Understanding a firesetter's behavior requires an assessment of each of these categories, and types of firesetters may eventually be defined by clusters or patterns of characteristics rather than by a single, overriding feature."

A picture of a "typical" adult firesetter is derived. Firesetting is just one of the person's several maladaptive behavior patterns which have social ineffectiveness as a common factor.

Index Words: Firesetters; literature review.

141a. Waller, M.B. and Vreeland, R.G. Report of a Conference on Fire Emergency Plans in Group Homes for the Developmentally Disabled. University of North Carolina, Chapel Hill. National Bureau of Standards Report No. NBS-GCR-81-315. March 1981. NTIS Order No. PB 81-180960.

This report is the product of a conference held on June 1, 2, and 3, 1980 in Chapel Hill, North Carolina. The participants in the conference were brought together to discuss guidelines for fire emergency plans in group homes for the developmentally disabled. Participants included a broad cross section of those concerned about fire safety in group homes for the developmentally disabled, including fire protection engineers, group home owners and operators, fire service personnel, as well as experts in training group home staff and in developmental disabilities, insurance, and behavior in fire. This report contains some of the substance of their discussions. The guidelines provided in this report include suggestions regarding training programs and facility fire emergency plans. A checklist for both local fire service personnel and group home staff is provided to assist these groups in developing adequate fire emergency plans. Recommendations are made in the areas of information availability, incentive systems, and evaluation procedures.*

*Annotation is the report's abstract.

Index Words: Boarding home; fire emergency planning; handicapped; training and education.

142. Wenger, D. Some Observations on the Nature of Panic Behavior: A Normative Orientation. In: Second International Seminar on Human Behavior in Fire Emergencies, October 29 - November 1, 1978 -- Proceedings of Seminar, pp. 214-217. National Bureau of Standards Report No. NBSIR 80-2070. Issued June 1980. NTIS Order No. PB 80 204738.

The term, panic, has varied meanings. The various usages, with some disparity of meaning and a lack of conceptual rigor, limit its usefulness as a concept for scientific study. From a nominalist perspective, however, the concept has utility in the fields of disaster research and collective behavior. Given an interest in examining the social forms of panic, it is proposed that panic be defined as mass behavior existent within a normatively competitive situation that results in increasing the danger to self and others, rather than reducing it. Individuals, in the context of a social crisis, engage in behavior that may be labelled as panic when the norms that emerge from their interaction define competition, not cooperation, as appropriate activity. Panic is neither irrational nor rational behavior. As opposed to considering rationality, attention should be focused upon the process of social interaction that results in a collective definition of the situation which proposes that competitive flight behavior is appropriate. Those conditions which produce panic in a given situation are discussed, including the existence of a social crisis, inadequate crisis management, and the milling process. It is noted that hope spurs panic, not hopelessness.*

*Annotation is based on the author's abstract with modifications and additions.

See also reference: Quarantelli, E.L. Five Papers...

Index Word: Panic.

143. Whittington, C. and Wilson, J.R. Fat Fires: A Domestic Hazard. In: Fires and Human Behaviour, edited by David Canter, Chapter 7, pp. 97-115. New York, John Wiley & Sons, 1980. 338 pages.

This chapter deals with the magnitude and nature of the problem of domestic fat fires in the United Kingdom through 1974. A variety of statistics are presented on the frequency of fat-pan fires, the causes of the fires, the appliances involved, actions taken by residents to put out the fires, and associated non-fatal casualties.

The problem is a significant one. Approximately one-third of all domestic fires reported in 1973 in the United Kingdom originated in cooking appliances. Approximately 80% of these resulted from the ignition of cooking fats. The rate of occurrence of fat pan fires reported to fire brigades on electric cookers (ranges) is over four

times that for gas cookers. The majority of fat fires result from the inattention of the person responsible for the cooking. The proportion of cooking appliances fires which involves a casualty is lower than for other major sources of domestic fires (although the overall number of non-fatal casualties associated with cooking appliances fires is greater than for any other source). The casualties which do occur seem to derive mostly from handling the pan to remove it out of doors.

Both hardware and behavioral approaches to the problem are described. A greater use of thermostatically controlled deep fat fryers and the marketing of temperature controlled warning devices attached to chip-pans are possible solutions to the problem. A television educational campaign providing prevention and extinguishment information which appeared to be successful in the short run is described.

Index Words: Fire incident statistics; residential occupancies; training and education.

144. Willey, A.E. The Lil' Haven Nursing Home Fire. Fire Journal, Vol. 66, No. 1, 21-26, January 1972.

On September 15, 1971, 6 of the 17 residents of the Lil' Haven Nursing Home in Salt Lake City, Utah died as a result of a fire set by a patient. He started the fire by spreading a combustible liquid and igniting it in a first floor sleeping room. The automatic detection system operated, sounding the local alarm bells and sending a signal to the Fire Department. Despite the fact that rescue and fire-fighting operations were begun within approximately three minutes after activation of the alarm system, five second floor patients died from toxic products of combustion from the uncontrolled fire which spread up the stairs and through the second floor corridor. A sixth patient died as a result of jumping from a second floor window. The stairway door to the second floor had been blocked open. There was a single door to the exterior serving the second floor which discharged from a sleeping room across a ramp to grade, and some patients did escape via this route.

The author concludes that this fire indicates the limitations of total reliance on automatic fire detection and manual fire-fighting to ensure reasonable life safety for patients.

Index Words: Alarms; fire fatalities; fire incident study; fire-setters; nursing home.

145. Wirth, I. Fire Safety in Urban Housing. Report No. UCB FRG 74-24. University of California, Berkeley. November 1974.

This paper describes the major study areas of an interdisciplinary fire research program of the University of California at Berkeley.

These areas are 1) housing materials and their reaction to fire, 2) building structure response to fire, and 3) human response to building fire. The human response was studied at 2 different levels, i.e., individual occupant behavior, and organized response by building occupancy as a whole. Their research to date regarding the role of individual residents in causation and control of unwanted fires in residential housing was mainly concerned with methodology development, particularly survey techniques for acquisition of data on: the incidence of minor fires, their relation to normal domestic use of fire and heat, and residents' readiness to cope with unwanted fire. To investigate behavioral aspects of fire safety organization in high-rise buildings, an initial field survey was conducted in the San Francisco Bay Area covering two or more high-rise buildings in each of the following classes: hospitals, office buildings, hotels, industrial buildings, and apartment buildings. The ongoing organizational commitment to fire safety and the fire safety equipment for each building was assessed. A table is presented which summarizes fire protection status by occupancy type.

Index Words: Fire emergency planning; fire incident statistics; high-rise buildings; hospitals; residential occupancies.

146. Wirth, I. and Crossman, E.R.F.W. Fire Safety Organization in High-Rise Buildings: A Pilot Survey and Analysis. Report No. UCB FRG WP 74-13. University of California, Berkeley. August 1973.

Reported are the results of a pilot survey designed to determine the current status of fire safety organization in high-rise and other large buildings. Detailed reports of nine interviews with persons (building engineers, superintendents, etc.) occupying active roles in the maintenance of the fire safety systems in such buildings are given. The report lists six types of organizations involved in fire safety issues in high-rise buildings and briefly assesses the degree and nature of involvement of each.

Index Words: Fire emergency planning; high-rise buildings; hospitals.

147. Wood, P.G. The Behaviour of People in Fires. Fire Research Note No. 953. Loughborough University of Technology, England. November 1972.

This study presents a general analysis of actions taken by people when confronted with a fire emergency, and a more intensive report on two particular behaviors--evacuation of the building and movement through smoke. A questionnaire administered by Fire Brigade officers at the scene of the fire was utilized for the main body of the study. Data was collected from nearly 1000 fire incidents, and the more than 2000 people who were involved in them. Listed are 7 classes of actions accounting for almost 80% of the first actions

taken. Findings are given with regard to the effect of such variables as previous training, previous involvement in fire, sex differences, etc., upon first action taken.

For some additional information on this reference, see the following entry.

148. Wood, P.G. A Survey of Behaviour in Fires. In: Fires and Human Behaviour, edited by David Canter, Chapter 6, pp. 83-95. New York, John Wiley & Sons, 1980. 338 pages.

A project was carried out under the direction of Peter Wood at the University of Surrey, England, to study a wide range of human responses to fire emergencies, and the relationship between these responses and variables such as sex, training, or previous fire experience. Data was collected from more than 2000 people involved in nearly 1000 incidents. Interviews were conducted by fire service personnel at the scene of the incident, using a questionnaire format. Slightly more than 50% of the incidents occurred in dwelling houses.

Behavior was examined at two levels: a general analysis of actions taken (including first actions and other actions in sequence) and a more intensive study of two behaviors--evacuation and movement through smoke. Statistics are presented on the percentage of participants undertaking various behaviors as their first action; on the percentages of people leaving and re-entering the occupancy broken down according to such factors as sex, the presence or absence of smoke, and previous involvement with fire; and on movement through smoke.

Some of the results were not anticipated, namely, the large percentage of people who moved through smoke, the high percentage who reentered the building, and the popularity of firefighting as a course of action. In particular, the absence in some cases of a clear relationship between training frequency and frequency of firefighting was surprising to Wood.

Some clear sex differences emerged. Women were more likely to warn others and evacuate the family while men were more likely to attempt firefighting. Men were also more likely to reenter a building and move through smoke. People who were previously involved in another fire were less likely to leave immediately and more likely to firefight in addition to moving further through smoke.

In this descriptive study, people were simply asked what they did in the fire situation without reference to other options they may have considered. Wood feels that, in future studies, participants

should be asked why they chose certain courses of action over others in order to provide the researcher with insight into decision processes.

Index Words: Evacuation; fire incident statistics; fire incident study; panic; residential occupancies; smoke, influence of; training and education.

149. Wooliscroft, M.J. The Hospital Fire Problem--Towards a Rational Approach. Fire, Vol. 68, No. 849, 511-512, March 1976.

An approach to the calculation of hospital fire risk is presented, with emphasis on the idea that efforts to reduce this risk be cost effective.

In the six years, 1968-73, some 90 people were killed in hospital fires. To put these fatalities into perspective, the risk of death in a hospital fire is compared with the risk of death in other settings. Statistics on multiple death hospital fires in Great Britain for the years 1968-1972 are given. These statistics indicate that the main hospital fire problem is the multiple fatality fire in a mental illness, mental handicap, or geriatric ward. In addressing this problem, it must be considered that "in spending money on fire precautions in hospitals, we are in principle deciding not to spend money on other things." The cost effectiveness of spending money on medical means of saving lives versus spending money on fire safety measures is considered.

Index Words: Fire fatalities; fire incident statistics; hospitals; risk.

150. Zachary, Wm.B. and Crossman, E.R.F.W. Manual Control of Unwanted Firespread by Building Occupants: A Preliminary Survey of Equipment, Techniques, and Behavior. Report No. UCB FRG WP 74-6. University of California, Berkeley. August 1973.

Statistics indicate that occupant fire fighting efforts are an important part of fire control. A case can thus be developed for increasing expenditure on occupant fire fighting facilities as against professional services. Water appears to be the primary extinguishant applied to fires by residential occupants. The report presents statistics on method of extinction of fires extinguished before arrival of professional fire fighters (United Kingdom, 1962 and Berkeley Firesafety Survey, 1971). The survey data tend to show that occupants use materials which are readily available (water, rug and towel, dirt), cheap, and familiar; and extinguishers appear to be used less than their availability would suggest. The author questions the value of an increased emphasis on provision of

extinguishers and suggests alternatives.

Index Words: Fire extinguishers; fire incident statistics.

151. Zachary, W.B., Crossman, E.R.F.W., Quan, E.C., and Condon, E.D. Household Fire Hazard and Defense Capability: A Survey Study of San Francisco High-Rise Residential Occupancies. Report No. UCB FRG 76-14. University of California, Berkeley. September 1976.

This report is part of a larger study to determine occupant response to and preparedness for fires. This particular report focuses on San Francisco high-rise residential occupancies. A one page survey questionnaire was used which sought information from residents about domestic fire-related behaviors. The topics covered were fire hazards, fire preparedness, fire incidents, fire policy opinions, and demographic characteristics of the respondents.

Some findings were: About 75% of the fire incidents occurring within the respondents' own households were not reported to the fire department; home materials were applied as extinguishants in 80% of the incidents in the sample; while fire extinguishers were frequently available and their locations known, relatively few respondents were aware of extinguisher type or would use extinguishers in actual incidents. Age and sex differences were found--for example, younger people were more likely to extinguish the fire themselves, and men appeared more certain with regard to coping with most types of fires but were less sensible with regard to smoking in bed.

Index Words: Fire emergency planning; fire extinguishers; fire incident statistics; high-rise buildings; residential occupancies; smoke detectors.

ORDERING INFORMATION

For those references that are available for purchase from either the Government Printing Office (GPO) or the National Technical Information Service (NTIS), the specific order number has been included at the end of the citation.

To obtain current pricing and ordering information regarding GPO documents, write directly to the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Indicate the SD Catalog No. or Stock No. for each document in which you are interested.

To obtain current pricing and ordering information regarding NTIS documents, write directly to the National Technical Information Service, Springfield, Virginia 22161. Indicate the NTIS Order No. for each document requested.

Ordering information regarding the training film, "Flashover: Point of No Return," mentioned in the Preface of this report is as follows:

A free film loan is available for some groups and may be obtained by writing to

Modern Talking Picture Service
5000 Park Street North
St. Petersburg, Florida 33709
or call, 813-541-6661

For purchase information, write

the National Audiovisual Center (GSA)
Reference Section
Washington, DC 20409
or call, 301-763-1850

The presentation is available as a 16 mm film, video tape cassette, or slide show.

U.S. DEPT. OF COMM. BIBLIOGRAPHIC DATA SHEET <i>(See instructions)</i>	1. PUBLICATION OR REPORT NO. NBSIR 81-2438	2. Performing Organ. Report No.	3. Publication Date December 1981
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10. SUPPLEMENTARY NOTES Sponsored by the HHS/NBS Life/Fire Safety Program <input type="checkbox"/> Document describes a computer program; SF-185, FIPS Software Summary, is attached.			
11. ABSTRACT <i>(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here)</i> <p>This report contains an annotated listing of 161 selected references pertaining to human behavior and fire emergencies. The scope is broad: the references cover the full range of behavioral responses through the different stages of a fire emergency in the context of a variety of occupancy settings. Health care institutions are the most frequently represented occupancy type. Many research approaches are included; e.g., case studies of individual incidents, survey studies of large numbers of incidents, theoretical analyses and representations of the fire situation, computer models, literature surveys, and psychological studies of selected populations. The work of researchers from many nations, including the United States, Canada, Great Britain, Japan, West Germany, France, Belgium, and the U.S.S.R., is referenced. Annotations for papers from the first two international conferences on human behavior in fires (March 1977 and October 1978) are contained in this bibliography. There is a topical index to provide the reader with a preliminary guide to those references regarding a particular occupancy type, research approach, design feature, or category of behavioral response. An introductory essay provides an overview of the field of human behavior and fires and develops some common themes found in the literature.</p>			
12. KEY WORDS <i>(Six to twelve entries; alphabetical order; capitalize only proper names; and separate key words by semicolons)</i> bibliographies; evacuation; fire alarm systems; fire fatalities; fires; high-rise buildings; hospitals; human behavior; nursing homes; panic; smoke detectors; sprinkler systems			
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