

# "CAUGHT BETWEEN A FIRE AND A HOT PLACE"

A REPORT ON HUMAN BEHAVIOUR IN FIRE  
FOR DR. A. BUCHANAN  
FIRE ENG. LECTURER

PREPARED BY  
GEOFFREY KING AND SIMON GRANT  
4/4/92

## TABLE OF CONTENTS

Summary.....	2
Introduction.....	3
Recurring themes in human behaviour.....	4
-The human component in the cause of fires...	4
-Patterns of early response activity.....	4
Factors influencing the behaviour of people ...	7
Awareness of fire.....	9
Fight the fire.....	10
Egress.....	11
Panic.....	13
Refuge.....	14
Behaviour affecting building design.....	14
Education and training to avoid disasters.....	15
Conclusions.....	17
References.....	18

**Cover Picture:**A man makes a futile attempt to jump from a burning building using a mattress to cushion the impact.  
**Photo** Compliments of "High Rise Buildings and Fire Safety".



*Excellent report  
Photos not well integrated into text.*

A

## SUMMARY

There has been extensive research carried out studying human behaviour in fire and the factors contributing to it. The research indicates the general public doesn't comprehend the speed at which a fire can take control over a building and the necessity to respect it. This lack of understanding unfortunately reflects in their inappropriate behaviour with cataclysmic consequences resulting.

We have explained the process involved in which humans become aware of fires and their resulting behaviour and associated actions.

We have mentioned the influences which encourage people to fight fires, and how confronting a fire increases the individual's stress levels resulting in misinterpretation of instructions thus putting the individual at risk.

Egress is discussed and factors affecting time to evacuate and egress route selection are mentioned. We talk about density of crowds and the associated behaviour affecting evacuation. The danger of evacuation using lifts is stressed.

The concept of panic is described and misconceptions about when people panic are revealed. We describe the phenomenon with respect to large crowds and give examples describing the unfortunate consequences.

Refuge is also covered, as to why, where, and how people seek refuge with respect to domestic and commercial buildings.

We look into how behaviour is now affecting building design and the problems associated with this due to the high speed of change in our society.

Finally we take a detailed look at education, training and management so as to control evacuation ensuring the requirements for egress are all taken into account thus resulting in emphasis of safety.

The loss of life in fires is usually due to a poor response to early fire cues and lack of urgency due to a blasé attitude to fire alarms. Failing to become familiar with evacuation routes and other fire safety procedures (if installed in the premises) leads to congestion along familiar evacuation routes.

The object of this report is to inform readers of these lapses in communication in a hope that future design of buildings will be more "user friendly" when coming to the evacuation due to an emergency.

✓

# INTRODUCTION

The study of human behaviour in fires is complicated by various difficulties not encountered in other areas of behavioural research. These difficulties mainly stem from the fact that fires are rare and unpredictable, therefore it is impossible to set up and study the actual behavioural responses of humans. Information in this field is gathered by questioning people having direct experience with fires. Unfortunately people having the most significantly critical information (i.e. those having close contact with the fire) usually perish during or after the fire.

There has always existed a variety of sources of information about human behaviour in fires provided through:

- Forensic examination of incidents giving insight to what actually happened with respect to human behaviour.
- Special commissions of enquiry and associated official investigations.
- Television footage.
- Newspaper reports.
- Common sense.
- Individual Experience.

Unfortunately this information is usually unique to the particular event, individual and their skills and experience. Therefore this information is not usually applicable to other situations. Hence, the material collected does not provide for the basis of a clearly articulated, cumulative data base.

In Great Britain and the U.S.A. standardised questionnaires were devised in order to analyse the reactions of people involved in a fire from the time when they first became aware of the fire until they had left the building. This included how a person became aware of the fire, their immediate actions, the effect of the fire drills or other training, familiarity with the building, behaviour on returning to the building and the effect of smoke.

The information from such reports goes towards influencing and shaping legislation governing safety aspects, increasing the knowledge of Fire/Civil and Mechanical engineers with respect to fire and thus hopefully saving lives.

## RECURRING THEMES IN HUMAN BEHAVIOUR

### (1) The human component in the cause of fires.

Now days the success of fire control leads to the majority of fire damage being the result of malicious human activity. There are several different types of arson, the main ones being:

- Profit, this is a common type of arson and involves insurance (Commonly called "Selling the business") and/or "Contract torches" (Paid fire starters).
- Adolescents - for kicks (peer pressure to fit in with friends)
- Children's fascination with flames (education at an early age being a solution).

### (2) Patterns of early response activity.

Once a fire is initiated, its seriousness depends upon reactions and patterns of activity of people associated with the fire. Response time is of vital significance and where fire leads to loss of life, slow response is usually one of the major constituents to the disaster. All researches seem to agree on two stages in the early response to a fire (with a 3rd stage being escape).

1st Stage - Recognition.

2nd Stage - Action.

#### 1st Stage

The early stage of fire recognition is typically characterised by ambiguities, thus reluctance in early acceptance (due to situation, circumstances and assumed severity) resulting egress frequently being delayed to a dangerous extent.

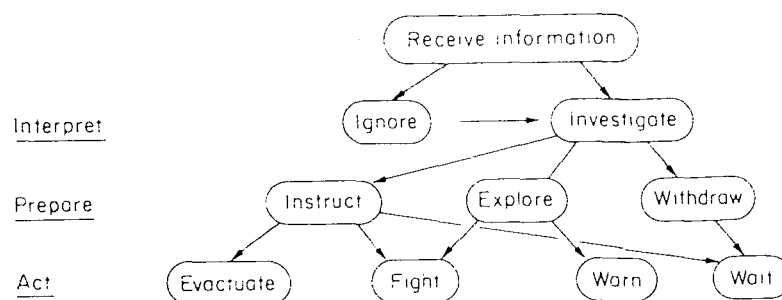
Humans react to stress in different ways. If stimuli is provided different individuals reactions depend on their perceptiveness and their susceptibility to stress, both of which are determined by that individuals makeup. The concept of perception is hard to gauge as it involves characteristics which do not exist in the mechanical world. Therefore we can not predict the individuals reactions to the perceived threats, but general theoretical and experience based models have been established on the basis of human stress behaviour.

Type and duration of a perceived threat will largely depend on the subsequent stress responses. If the stress is very specific and the duration of the perceived threat very short then individuals may exhibit a fairly well defined range of stress reactions. If however the stimulus is more general and the period of perceived threat longer, as might well be in a fire situation, then we would expect the individuals to demonstrate a "Repertoire of Responses". Therefore length of time with respect to perceived threat and the presence of a undefined or unclear stimulus can result in delay to recognition i.e. ambiguous appraisal of the cues present. This, linked with the well-known "Personal Invulnerability Factor" ("It can't happen to me") leads to regarding of such cues optimistically. This process of indirect denial seems to indicate the individual is not welcoming an increase in stress levels therefore unconsciously wants to disregard these initial cues.

## 2nd Stage

Once the individual has recognised that there is something wrong the ambiguity of the initial cues directs the individual to try and verify the nature of the stimuli. To do this the individual has to "get his bearings" and try to structure the situation in terms of their perception of the threat and in terms of their personality, training and experience. Since most individuals have not had great experience in this type of situation, attempts at placing order-structure into the situation may be frustrated. In some instances this inability to structure the situation may well start a vicious circle which could initiate an increase in the level of stress. It is clear to the individual that some response is required, but because the situation is not clearly defined, the individual cannot initiate any behavioural action. This is where the decision-making ability of the individual can save precious time. The individual has to weigh up various actions and consequences, i.e. "if I fight the fire, will I be endangering myself?". If this action is decided upon and is successful in combatting the fire the individuals stress level will decrease. If the fire gains momentum the individual would have to reassess his or her situation. If flight is the decision, as the individual escapes they may undergo massive stress relief, which can also be very dangerous. This can initiate reassessment of their responses resulting in a realisation that he/she over reacted to the threat of the fire and the degree to which their life was in danger. This can transfer perceived threat to belongings and property, thereby encouraging the individual to re-enter the fire. Another possible action is to call for assistance. This will involve leaving the fire scene. Once away from the fire the individual will transfer responsibility from him or her to the fire brigade or some other receiver. This passing of information and responsibility of fighting the fire can also lead to a large stress relief. With no responsibility with respect to fire fighting, the individuals focus may change to recovery of property and belongings, thus encouraging the individual to re-enter the fire. If the initial decision made does not result in stress relief for the individual, this combined with inability to structure a clear picture of the situation, the stress experienced by the individual will increase due to his/her failure to adapt. This can lead to the development of more primitive responses and associated actions. Rational thought may be overwhelmed, resulting in non adaptive, non-rational responses and associated actions. This can lead to the initiation of two types of behaviour. The "Frozen with Fear" complex which is very rare and more frequently the panic response.

*Fires and Human Behaviour*



Summary of general model

Diagram compliments of "Fire and Human Behaviour",  
Canter D., 1990

Put the figure in center of  
page to break up the text

### 3rd stage

Process of escape (once decision to escape has been made). Activity now has a single focus which is escape. Hazard free egress is not always possible due to the nature, conditions and situation surrounding the fire. This is explained further in this paper in a section titled "Egress".

✓

## FACTORS INFLUENCING BEHAVIOUR OF PEOPLE

Knowledge of behaviour and physical limitations of occupants in a building during a fire is extremely important along with preventive fire protection, when a building is planned. The behaviour of the occupants will play a major role in determining the outcome of events in a fire situation. Incorrect or inappropriate behaviour can complicate the work of the fire brigade by the fact that they are not only required to fight the fire but also, rescue people who may be close to panic and/or who are trapped within the building. Since exposure to a fire inside a building is a rare occurrence, the lack of experience or training means the behaviour will be instinctive. Peoples behaviour will very depending on whether they are faced with a fire which is still developing which could be extinguished easily, or whether it is a fully developed fire.

Another factor influencing behaviour is whether they are permanent occupants of the building (because they live or work there), or only temporary occupants (eg. hotel or entertainment hall guests), or if their freedom of movement is restricted (eg. patients in a hospital). In an entertainment hall the number of people, and the number and location of exits will significantly affect their actions. (Kirkpatrick 1988)

In the M.G.M. fire (Bryan 1980) it was found that males were more likely to carry out actions such as checking the doors for heat and placing towels at the base of the doors while women were dominant in securing valuables and notifying roommates and other rooms.

Many guests turned on radio and television but received no specific information on the fire location and the efforts being made to evacuate them or as to what actions they should adopt. Some with working phones rang the fire department and obtained information concerning a recommended survival plan.

In places of entertainment large numbers of people are concentrated in a confined space. Unlike large divided buildings they do not provide areas of refuge to avoid the fire. Survival requires an efficient and organised evacuation through available exits. In the "Stardust Hotel" fire in Dublin (Bodamer 1989) visitors stood around hesitantly in the initial stages of the fire while several people even ignored the fire and carried on dancing. As the fire developed the exits became crowded. The doors of the main entrance wrongly opened inwards causing a hold up in the main hall and consequently increasing the congestion at the other exits.





**Rescuers attempt to remove steel bars from toilet windows where people became trapped after thinking they had found an exit.**

Photo compliments of "Fire Prevention # 224 November 1989"

## AWARENESS OF FIRE

Strange noises and smells are usually how people become aware of fires and consequently much of their early behaviour involves clarification of the situation. This may lead to an activity which may appear irrational to an observer or investigator with the benefit of hindsight. In the M.G.M. fire, seeing and hearing the fire apparatus was found to be the most frequent way the guests were first informed of the fire.

When people are involved indepth in an activity, for example trying on clothes or eating a meal there will be a tendency for them to try to complete their task before responding to the fire cues. Surveys indicated that approximately 20% of people evacuated were reluctant to leave because they thought the alarm was more likely to be due to malfunction, practical joke, test or fire drill.

Non reaction is due to denial that the danger is real or lack of recognition and awareness due to a shortfall of knowledge or incorrect interpretation of the facts.



## FIGHT THE FIRE

People approach the danger of fires for a variety of reasons. This could be to increase knowledge, for self-fulfilment, to save their own life or others and be named a hero or to demonstrate a personal skill or ability. The individual when in the face of danger and limited options will commonly attempt some form of fire fighting until the individual realises that fighting is futile.

In a Study by D. Canter (1980) on four fires (Residential Hotel, Hospital, Pub and High rise block) it was established that people found extinguishers difficult to use. In one fire, out of 131 people, 106 made no attempt to fight the fires, while 9 fought them by means other than extinguisher. Of the 61 people who had access to extinguishers, only 16 attempted operation and of that 16 only 2 were successful on their first attempt. (Kirkpatrick 1980). This is a strong indicator of the stress occurring while confronting a fire i.e. due to urgency of the situation instructions on use of the extinguishers were not read or interpreted correctly.



Hotel fire, Seoul, Korea, 1971. Firemen play high pressure water onto the hotel while broken bodies litter the footpath. Photo compliments of "High Rise Building Fires and fire Safety".

## EGRESS

With respect to fire, egress may be defined as the action of evacuating a building through various routes and exits so as to avoid charring! Of the total time to egress a building, the largest portion of it is spent between first awareness of the fire and initiating the action to escape.

Smoke indicating danger will influence the egress route thus hopefully directing the individual away from danger. This is due to the will to survive and desire avoid injury. In hotels or places of entertainment, guests will evacuate through a route familiar to them while staff will leave by designated and/or alternative means of egress. The rejection of unfamiliar routes is caused by a lack of confidence in the route brought on by a fear of the stairs/exits being obstructed/locked, not knowing where they are going or if it will take them to safety. All designated routes of egress should have clear and visible signage thus enhancing peoples awareness of other exits.

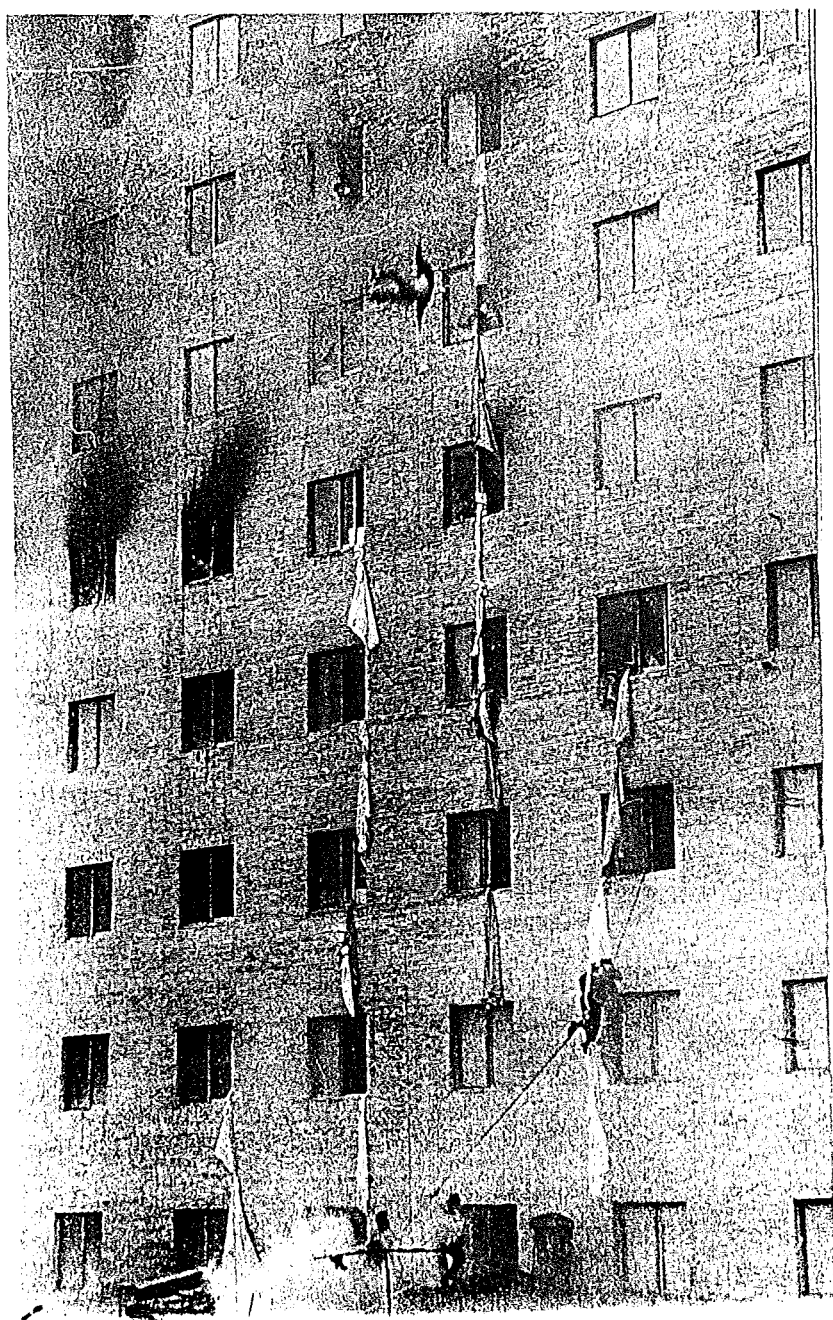
Mass exits from sports grounds due to fire cause people move at speed through restricted exits causing congestion and may result in people being crushed to death or their inability to escape and thus being overcome by smoke and/or flames.

Overcrowding in a place of entertainment can have disastrous consequences as with the rush to get out, people are pushed to the edges by the surge of bodies and forced along the walls until they reach a corner and can move no further.

Occupants using the lifts for egress are often trapped and overcome by smoke due to power outage to the mechanical services.

One research paper in the United Kingdom found that out of 200 people evaluated who had escaped successfully, 44% of them had re-entered while the fire was still in progress. The reasons for re-entering were to secure personal effects, find friends, relatives missing or simply to observe the progress of the fire making the fire services task just that more difficult. (Kirkpatrick 1988)

A selection of non-disabled, disabled, blind, arthritic and elderly people were asked to perform a series of activities to simulate evacuation in the event of a fire. The studies demonstrated that some people with major difficulties can evacuate well within the 2.5-3.0 minutes that a private home with typical safety features normally provides its occupants for escape from a fire. The report concluded that with no unnecessary barriers disabled people can get out in a timely fashion. (Levin B.M. 1984)



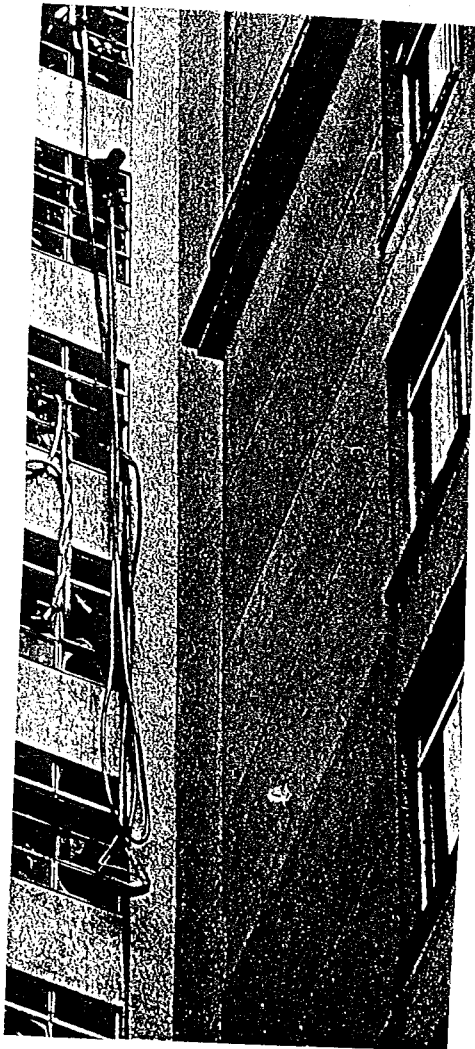
Photos compliments of "High Rise Building Fires and fire Safety".

## PANIC

The definition of panic has a large scope for interpretation and has been described as mass flight of irrational terrorised people, to a feeling of fear and helplessness. A universally accepted observation is that people panic when confronted with an uncontrolled fire. Although this is what is accepted there is little evidence to back it up. In fact contrary to this, are facts indicating that people tend to carry on with what they were doing, calmly keeping to their normal routines as reported in the Kings Cross Underground Railway Station disaster in 1988 (Canter 1990) and the Beverley Hills Supper Club in 1977, where waiters and waitresses calmly showed their respective tables out through the smoke to safety. (Canter 1990) While panic is rare, the regard for others usually increases resulting in acts of heroism not being uncommon. ✓

In extreme danger, disorderly evacuations do occur with some aggressive behaviour bought on by panic, especially if exit capacities are grossly insufficient or blocked (Kirkpatrick 1980).

Examples of panic or non-adaptive behaviour in the M.G.M. fire (Bryan 1980) were the fights to get onto helicopters and the falling or jumping of two guests from the hotel. ✓



Photos compliments of "High Rise Building Fires and fire Safety"

## REFUGE

In most building fires, occupants will first try to find areas in the building where the smoke is less dense. If the fire is fully developed and the production of smoke and heat is great, the occupants tend to either to remain in their rooms or flats or if they are already trying to escape, find a safe place within the building. This leads to the formation of what is called "Convergence Clusters of People". People in convergence clusters are generally more able to cope with a situation than people on their own.

In domestic situations, firemen quite often find occupants who have been unsuccessful in their attempt to escape and have sought refuge only to be overcome by smoke.

In the M.G.M. Grand Hotel fire it was found the 1st critical decision was to stay in their rooms or to leave and use the stairs. For many guests the decision was made based on the amount of smoke visible in the immediate corridor. The next critical decisions were made when guests found the stairs full of smoke or were descending the stairs and met smoke rising. On finding exit doors from the stairs locked, the guests retreated and sought refuge in rooms with nil or minimal smoke (Bryan 1983).

## BEHAVIOUR AFFECTING BUILDING DESIGN

In order to plan for new buildings and usages we need to have an understanding of what fundamental psychological and social process will be relevant to any particular emergency or fire incident. This is extremely difficult, because we don't know what the future holds and that it's possible for society to change. So we must be flexible in our design to hopefully cope with any changes in society and to do this we need to be aware of the following three aspects.

- (1) We are now designing more complex building forms than in the past. In the future these buildings are open to very rapid changes and developments in their use.
- (2) Not all building forms, which change over time, are possible to plan for on the basis of previous incidents. If we look back and analyse previous incidents it is difficult to know what aspect of incident can be extrapolated to the new changing circumstances.
- (3) The trend is that there is an increasing novelty and variety of building usages. The Summerland fire, 1973 and the Beverley Hills Supper Club fire, 1977, both occurred in types of building form, structure and layout being used for a variety of purposes, which would have been unknown 50 years ago when many of the fire regulations were founded.

Therefore there must be some thought put into the planning of new buildings so as to hopefully enable the building to change usage without being dangerous to its occupants.



## EDUCATION AND TRAINING TO AVOID DISASTERS

The causes of fires whether technical, malicious or by freak acts, and preventative measures required to avoid and contain dangerous fires are well understood. This has led to the development of fire standards and regulations so as to minimise the threat of fire and help save lives. Even so the area of training and educating the public as to the procedures to follow in the case of an emergency are not emphasised to the extent they should be.

To enable the effective training and education of the public certain aspects need to be closely examined with respect to safety and efficiency.

Setting or environment must be considered. Knowledge of the setting is valuable in considering the consequences and implications of any approach to controlling and extinguishing fires, i.e. the general view that the average household is safe means that most indications of danger are likely to be ignored initially with respect to that setting, compared with say a steel factory in which training to be alert to a wide range of dangers is an essential part of employee education.

Another aspect to be emphasised is that people have to be trained so they are aware of what cues to look out for. The first indications of fire are not as commonly thought, flame billowing out of a building, but usually are sounds (crackling of timber, falling glass etc.), smells (smoke and fumes), reflected light and visual and verbal attempts at communication by other members of the public. In conjunction with this people have to be educated about the fact that the rate of fire growth increased with time. A small manageable fire has the potential to turn into a uncontrollable inferno in a matter of minutes.

There is a need to develop a warning system that will produce more effective responses from the public. To accomplish this we need to address several problems;

**Problem:** People failing to recognise a fire alarm as being distinct from other types of alarms.

**Solution:** The intent of the fire alarm must be obvious and it must be distinct so as not to be confused for any other type of warning device.

**Problem:** The attitude that fire alarms are not authentic warnings of a genuine fire i.e. due to frequency of tests and false alarms.

**Solution:** An alarm system must be developed so as to be a reliable, valid indicator to the presence of fire.

**Problem:** Lack of information as to the nature of the fire thus limiting victims in their attempts to deal with the fire.

**Solution:** A system needs to be developed where information about the fire can be presented at various locations throughout the building. This would inform occupants as to what was happening with regard to extent, rate of and direction of spread. Thus occupants could take evasive action.

Note, a great deal of research is going into systems encompassing all the above criteria resulting in development of new age "Informative Fire Warning Systems" (I.F.W.S.). One final aspect which needs attention is informing occupants of what to do in case of

*Very dense text*



fire i.e. escape routes and positions of fire fighting equipment.

Educational procedures required in our modern buildings and organisations encompass the need for evacuation plans and associated training. This should be designed in relation to local knowledge and experience of all uses. This is to deter people from using only the routes they are familiar with, as this causes an uneven distribution in the exodus procedure which can result in congestion. Therefore there is an importance to have prepared plans and procedures for dealing with emergencies. For the plan to be effective communication must be clear and concise, the plan must take into consideration the organisation structure and the physical layout of the building.

This plan must then be exercised in the form of fire drills so as to ensure its effectiveness and the education of the occupants. There is a need to stress to the occupants the seriousness of the plan and associated procedures. The following points are a summary of the essential components required for an efficient and effective plan.

- (1): Instruct key personal so they comprehend the conditions under which first aid, fire fighting and building evacuation should be executed.
- (2): That the call for building evacuation is exactly that, i.e clearly and unambiguously indicating that the building should be evacuated.
- (3): All communication and instructions conveyed to building users is unambiguous with intentions being direct and clear.
- (4): All evacuation sequences and routes are clearly understood.
- (5): There is clear and concise communication between the chain of command and critical members of the organisation.
- (6): All difficulties in evacuation, due to special circumstances are realised and dealt with.
- (7): Knowledge of location and use of fire fighting equipment is essential.
- (8): Clear and constructive feedback is given to all those who participated in the drill with recommendations for more efficient evacuation.


Hence there is emphasis put on building layout, fire safety systems and plans for evacuation systems so in a fire situation loss of life will be kept to a minimum. The challenge is to design, maintain and operate building fire safety systems and provide effective evacuation plans so that efficiency in the event of a fire is at an optimum thus drastically reducing the chances of fatality.

## CONCLUSION

The purpose of this paper has been to stress and illustrate the wide scope of behavioural patterns humans undergo when faced with a fire, and ways of altering these behaviour patterns to ensure rational and constructive actions. As discussed its ambiguity and confusion, incoherent instructions and time wasting actions, lack of appropriate instruction and misunderstanding of the nature of the event, which are hallmarks of fire emergencies that kill people.

There is a need to ensure that legislation calls for enforcement of safety regulations, alarm, detection/suppression systems are always operational. There is a requirement for thorough training of staff in the use of predetermined evacuation procedures and an increase in the general awareness of the public at large.

It was found in our research on this topic that there is a need for more psychological input and liaison between Civil, Mechanical and Fire Engineers. Working together the Engineers can determine the refining required in building design to facilitate quick and unimpeded progress from a fire scene.



## REFERENCES

- (1) Clarke R.C., "Behaviour in the Face of Danger", Annual Conference, Aston Health and Safety Society, Birmingham, U.K., 1983.
- (2) Bodamer, M., "How People Behave in Fires", Fire Prevention 224, November 1989, N.Z. Fire Service Library, Wellington.
- (3) Kirkpatrick T., "Human Behaviour in Fire Situations", Fire News, January 1988, N.Z. Fire Service Library, Wellington.
- (4) Gutmann R.P.E., "Let's Complement 'Stop, Drop and Roll'", Firehouse, April 1989, N.Z. Fire Service Library, Wellington.
- (5) Levin B.M., "Human Behaviour in Fire: What We Know Now", S.F.P.E., Technology Report 84-3, Maryland, U.S.A., 1984, N.Z. Fire Service Library, Wellington.
- (6) Bryan Dr. J.L., "An Examination and Analysis of the Dynamics of the Human Behaviour in the M.G.M. Grand Hotel Fire", Nat. Fire Prevention Assoc., Nov 1980, Nevada, U.S.A., N.Z. Fire Service Library, Wellington.
- (7) Wood P.J., "The Behaviour of People in Fires", Fire Research Station, Fire Research Note #953, Loughbrough, England, Nov 1972, N.Z. Fire Service Library, Wellington.
- (8) Babcock C.I., "High Rise Building Fires and fire Safety", Nat. Fire Protection Assoc., Massachusetts, U.S.A.
- (9) Canter D., "Fire and Human Behaviour", 2nd Ed., David Fulton Publishers, London, 1990.

Cont. list.