BEHAVIOUR UNDER STRESS: PEOPLE IN FIRES

by

PETER GILBERT WOOD (BSc)

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Supervisor: Professor A B Cherns
Dept of Social Sciences

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SUMMARY

This is a report of an investigation into how occupants react to a fire in a building.

Although there has been little directly relevant previous work, a number of allied research areas appear pertinent. These studies fall broadly into three categories, namely disaster research, panic research and fire simulation research. From these one may derive a general conceptual model which postulates that the determining factor in stress behaviour is the need for the individual to reduce, by whatever means are available, the level of perceived threat.

In view of the limited resources available, the original research plan envisaged the collection of in-depth information from a small sample of fire incidents. A Pilot Study conducted on this basis, with the researcher acting as interviewer, indicated a number of serious difficulties. A second Pilot Study was undertaken utilising Fire Service personnel as the agents for data collection. This proved to be a feasible technique, and a revised research plan was conceived incorporating both large scale and small scale studies. This strategy called for a quantitative examination of behaviour in a broad range of fire incidents, together with a qualitative investigation of a sub-sample of these, fires which resulted in rescues, injuries and fatalities.

Twelve Fire Brigades covering a wide variety of hazards agreed to participate in the main study. A questionnaire was devised for recording details of the incident and occupant behaviour at the time of the fire. By this method 2193 building occupants were interviewed at the scene of 952 fire incidents.

The resulting information was considered under four main headings, namely Fire variables, Building variables, Personal variables and Behavioural variables. Considerable effort was expended in defining the severity of the fire, and eventually a series of measures were used, including a derived Fire Severity Index. Dwellings constituted 62% of the sample. Behaviour was examined at two levels, a sequential analysis of the actions which individuals undertook, and a specific study of responses involving evacuation, re-entry and movement through smoke.

The main findings of the quantitative study were that incidents in Dwellings differed substantially in the nature of the fire, characteristics of the occupants and manifest behaviour from other occupancies. Dwelling occupants were more likely to be women, untrained, without previous experience of fire, and to consider the incident extremely serious. They tended to be concerned with contacting the Fire Brigade or with actions which minimised the risk, and during the course of the incident were much more likely to leave the building. The exception to this were the occupants of high-rise flats who left the building less frequently than people in other types of dwelling.

Over all occupancies the main effect of increasing Fire Severity was to decrease the proportion of people who contacted the Fire Brigade or fought the fire, and increase the proportion who warned others and left the building. Occupants were relatively accurate in assessing the seriousness of the fire. Men were more likely to return into the building and to move through smoke.

The qualitative study of fires involving rescues, injuries and fatalities revealed tht these were much more likely to occur in Dwellings. The incidents were generally of High severity. Whilst fires involving rescues and fatalities share similarities, incidents involving injuries have different characteristics. The majority of the Injury incidents involve attempts to move a burning object, often a chip pan. Matching the Fatal incidents with Non-Fatal incidents of equivalent Fire Severity showed that inappropriate behaviour was a causative factor in the majority of the former.

It is suggested that future studies to examine general behaviour in fires should concentrate on in-depth examinations of a small sample of incidents. A specific investigation designed to alleviate the major problem caused by cooking fires is also strongly recommended.

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CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

This research project was undertaken to study the behaviour of people who were involved in fires in buildings. Due to the difficulties associated with such studies, there have been few systematic attempts to examine the behaviour of a cross-section of the population in real-life stress situations. The Present Study must therefore be regarded as exploratory research. Other than the general theoretical framework suggested by previous work on human reactions to stress, there are no established models from which to draw hypotheses. Indeed, remarkably little is known concerning individual or group reactions to fire, other than accounts which are carried in the news media. By virtue of their news-value, such incidents must, by definition, be unusual in some way. Often this distinguishing characteristic is in terms of the number killed, the age of the victims, the severity of the fire, or the particular type of building involved. The above factors all carry some emotive value which ensures they are reported to the public at large. It would be unwise, however, to conclude that the behaviour in such fires is necessarily representative of behaviour in all fires. We cannot therefore restrict our study simply to these incidents.

The aim of the Present Study is rather more ambitious, in that we are interested in describing, and attempting to interpret, behaviour within the whole range of fire incidents. This will include fires which differ widely in their characteristics, occurring in a variety of building categories, occupied by a broad spectrum of individuals. As an initial step we will attempt to define the population of occupants, which is the subject of inquiry.

1.1 THE STUDY POPULATION

Each year approximately 800 people are killed in fires, 4,000 are injured and approximately 3,000 are either rescued or escape from buildings by emergency means. If we define involved as "occupying the building at some stage in a fire incident whilst aware of the fire", we may argue that such individuals represent the extreme values on a scale of involvement in fires. The population which is the subject of this investigation must be much larger, comprising as it does all people who are exposed to the threat of fire without necessarily being injured by or rescued from it. The actual size, however, is difficult to define. We may attempt to estimate it for specific types of building by amalgamating information from several sources (see Appendix 1, p.321). In Dwellings, for instance, the number of persons involved each year is estimated at 95,460. Figures for other types of occupancy are much more difficult to estimate as there is little immediately available information on which to base calculations. In a fire in a large factory for example, it is impossible to know what percentage of the individuals within the establishment were aware of the fire. Extending the range of assumptions however, it is possible to arrive at estimates for other occupancies (see Appendix 2, p.322). On this basis it is tentatively suggested that the total population of persons involved in fires may be as large as 365,460 in a given year. The overall probability of being involved in a fire is thus 6.5×10^{-3} per annum, although this will naturally vary between occupancies. For instance, the overall risk to a hotel guest appears to be some ten times as large as that to a person in his own home, although the risk of being killed is substantially the same (Fry, 1969).

1.2 FIRES AS A CATEGORY OF ACCIDENT

Fires are generally regarded as a specific category of accident, and their incidence is often compared with other categories, such as road traffic and industrial accidents. It has been shown (Warne et al, 1971), that in the case of injury-producing fires such comparisons are valid, and that such fires conform to a three-stage model of the general accident process involving exposure to risk, the start of the accident and the occurrence of injury. Fires however differ markedly from most types of accident in that the time over which they take place is relatively long, whereas most other accidents are of very short duration. The important implication of this extended time period is that for fires, in contrast to other accident types, the opportunity exists for a wide range of behavioural reactions, upon the success of which is largely dependent the occurrence or extent of injury and damage.

The most satisfactory method of studying an event is to observe and measure its characteristics as it occurs. In general, this is not a feasible technique for studying accidents because of their comparative rarity and their unpredictability in time and space. To overcome these difficulties, on-the-spot methods of investigation have been developed successfully in many fields of accident research (Haddon et al, 1964). Such methods have utilised techniques for the analysis of objective evidence, crumpled metal, skid marks, injury-type, failed instruments and so on, to supplement the statements of eye-witnesses and victims in reconstructing the course and behaviour of people in accidents. However the destructive nature of fire renders the collection of post-hoc objective evidence more difficult. Forensic experts can estimate causes of ignition and spread of fire within certain confidence limits, but in many cases this evidence can only be related to the behaviour of the fire participants in the most general way. Attempts to study fire accidents are therefore inevitably more reliant upon subjective reports than other categories of accident.

A further important disparity between fires and other accidents is that almost all fires in which people are involved offer a potential threat to life. That this fact is not unrecognised is shown by the results of a recent survey conducted for The Home Office (Sales Research Services, 1968). More than 70% of a sample of city dwellers interviewed confessed to being afraid of fire, 30% of whom classed it as their worst fear. The special nature of fire is also recognised by the Legislative, in respect of the precautions and regulations which are drawn up to protect the occupants of buildings.

1.3 FIRE PROTECTION

The principles upon which present codes of practice governing fire protection were first laid down in the Fire Grading Report No.29 (Board of Trade, 1952). This report was based upon a mixture of then-existing scientific knowledge, practical experience and commonsense (Silcock, 1969). A major preoccupation of this and subsequent reports has been planning for means of escape. Briefly, the over-riding principle is that in theory a man should be able to turn his back on a fire and escape by his own unaided efforts. A critical factor in escape planning is "travel distance", which is the distance involved in moving from a location within the building to a "position of safety". The position of safety may be defined as the exit of the building or alternatively a fireresisting enclosure, and travel distances are measured accordingly. In essence the travel distance is an estimate of how far an individual may have to move through smoke. The basis for recommended travel distances is intuitive rather than scientific. There has been some research on the movement of people in buildings (Hankin and Wright, 1958), and on the movement of crowds (Henderson, 1971). However, the relationship between these measures of subjects moving under non-stress conditions and movement under threat of fire has never been explored. Furthermore there is no evidence extant concerning the degree to which individuals will move into smoke.

Much escape route planning is based upon concepts of ideal behaviour. For example, the effectiveness of most escape routes is dependent upon the self-closing nature of fire-check doors. It is a common observation of everyday life that a door placed across a line of communication or access will eventually be secured permanently open. The value of the door as a fire or smoke-check thus becomes zero, and the potential effectiveness of the escape route is consequently degraded (Silcock,op cit).

The codes of practice apply only to certain categories of building. Dwellings for instance are not included, although they account for 50% of fires in buildings. In addition, there have in recent years been many changes in the design and size of buildings. It is conjectured that traditional escape planning, based upon total evacuation, may be inappropriate in some large and complex buildings.

1.4 DISCUSSION

The brief outline above has been included to provide some insight into the principles underlying codes of practice for fire protection in contemporary buildings. Research efforts in the Present Study were not directed towards investigating any specific aspect of the codes, but rather addressed towards examining the general problem of behaviour in fires. However the inclusion of certain of the study variables was influenced by their obvious relevance to the provision of means of escape from buildings.

In view of the clear dependence of effective escape planning upon knowledge of human behaviour, it is surprising to discover that there has been little attempt to systematically investigate the patterns of behaviour which people adopt when faced with a fire situation. The costs associated with the fire protection of buildings are large, being estimated at typically some 5% of building costs (Maskell, 1971). Yet many aspects of such provisions are based largely upon intuitive notions of how people will behave.

There is, of course, a large amount of literature associated with people in fires. Much of it however consists of post-hoc speculative accounts of incidents and subsequent unsupported assertions concerning behaviour. Inevitably incidents of spectacular reaction to fire receive disproportionate publicity and are perhaps thought to be the norm for behaviour in fires. Yet it is not known to what extent such behaviour occurs, not what characteristics of the individual or the situation will determine its occurrence. There can be little doubt that involvement in a fire is perceived as an extremely stressful experience. The study of human stress is acknowledged as an important area within the behavioural sciences, and findings from many diverse fields may be relevant to the study of behaviour in fires. We will examine some of them in the course of reviewing previous research in the following chapter.

CHAPTER 2

PREVIOUS RESEARCH

2.0 PREVIOUS RESEARCH

As stated earlier, there has been little scientific work concerned specifically with behaviour in a fire situation. The majority of the literature is centred upon accounts of large, multiple-fatality fires such as the theatre fire in Chicago in 1903 (Foy and Harlow, 1928), or the night-club fire in Boston in 1942 (Benzaquin, 1959). Such incidents have been described as classic "panic" incidents. However the accounts of them are essentially journalistic and descriptive, providing few clues to the determining conditions of non-adaptive behaviour. Studies in the fields of disaster research and psychological stress are more fruitful, and provide the basis for a theoretical framework within which we may attempt to interpret behaviour in fires.

2.1 DISASTER RESEARCH

The first systematic studies of disaster were conducted soon after the Great War (Prince, 1920). Much of the work originates in the USA, and has recently become preoccupied with the possible consequences of nuclear attack (Healy, 1969). The term "disaster" implies extremely widespread death and destruction, and indeed most of the studies have concentrated upon very large scale disasters. In many cases they were the consequence of climatic or geological phenomena, earthquakes, floods, or tornadoes. Many studies have concentrated on the effect upon the community as a whole and its organisations. Perhaps one of the most comprehensive was that conducted by the National Opinion Research Centre between 1950 and 1954 (Dill, 1954). The data is based upon approximately 1000 interviews of people who had been involved in more than 70 disasters, ranging through tornadoes, explosions and earthquakes to aircrashes, industrial fires and accidents. The main findings of the study were that panic behaviour was in fact comparatively rare, and that the amount of warning given of an impending disaster could have very substantial bearing on actions taken. There was some evidence that inadequate warnings could lead to more substantial loss of life than no warning at all. A similar study was conducted by the Disaster Research Group of the National Academy of Science (Fritz and Marks, 1954), although in this case attention was focussed more upon the organisations involved in disasters. A useful division of disaster research into seven phases was proposed

(Powell, 1952), and much of the work may be classified under this system. The phases are (a) Warning, (b) Threat, (c) Impact, (d) Inventory, (e) Rescue, (f) Remedy and (g) Recovery. Clearly all the stages may not apply to different types of disaster, and some of the divisions appear rather tenuous. For example, it must often be very difficult to distinguish between warning and threat. Lazarus (1966) considers threat to be the key intervening variable in all psychological stress experiences. It is defined as the process whereby a stimulus is perceived as being harmful. It would appear that the perceived characteristics of the threat are a determinant of the magnitude of the anxiety created by the threat within the individual, and this anxiety may be a critical determinant of the behavioural response adopted. Withey (1962), in his study of behaviour in disaster situations, has established some of the essential characteristics for the perception of threat which, it is considered, influence the generation of stress for the individual within the threat situation. It is worthwhile considering these characteristics in terms of behaviour in fires. The perceived threat can be thought of as having a number of components which may influence the stress responses.

(i) The Probability of occurrence

The more probable the indivudal perceives the threatened stress to be, the more strenuous will be his attempts to avert it. As the probability of the threatened event increases, then the individual will be prepared to exert greater effort in his adaptive responses. In the case of a fire situation, the initial discovery of the fire will involve the perception of some "cues" that there is a fire, the smell of smoke perhaps, or the sound of burning. The question which is posed by these cues is "What is the probability that there is a fire?" If the cue is ambiguous and the threat perceived to be of low probability, then it will involve consideration by the individual of the "expense" or effort involved in his behavioural reaction. This is clearly one of the reasons for the apathy which is shown towards fire drills. The probability of there being a fire is perceived as very low, contrasted with the perception of the high "cost" of such action in terms of time, inconvenience and effort.

(ii) The Nature of the threat

The second component is the nature of the threat in terms of its severity. This is clearly related, in terms of fire, to the previous experience of the individual. The great majority of the population will have had no training, or experience in recognising the cues leading to the correct evaluation of the nature of the threat. Even if this were not so, the initial stages of a fire often produce cues which are ambiguous in nature. Often, only the appearance of flames seems to dispel any doubt as to the nature of the threat. It seems likely that the consideration of the severity of the threat is assessed by the individual in extremely personal terms. Thus the question is not only "If there is a fire how severe is it?", but also "To what degree does it threaten me personally?" Clearly the most severe threat is considered to be that to one's life, or the lives of one's family. It has been suggested that this ultimate threat is the determining variable in the production of a "panic"-type response. The concept of panic will be discussed in some detail later.

(iii) The Imminence of the threat

The third component of perceived threat is concerned with the time factor, the imminence of the threat. The question this time is "How soon will it threaten me," The closer in time the threat is perceived to be, the more likely that the stress response will be non-adaptive or non-rational. Published accounts of serious fires (National Fire Protection Association, 1967) usually report a condition of very rapid appearance and spread of fire and smoke. Conversely, when the threat is interpreted as being remote in time, the individual may postpone adaptive responses.

(iv) Coping with the threat

The fourth component is the possibility of adaptation to the threat. In this context, adaptation means "consideration of the power of the available actions to prevent harm". The most obvious is the possibility of escape. The urge to escape is primitive, and is likely to occur very early in severe stress. However, adaptation may take place on several levels and may, in the case of fire, involve such learned behaviour as attempting to extinguish the fire or contacting the Fire Brigade. In some cases of prolonged stress, such as a mine disaster in which men are trapped underground, it has been observed that the initial response is strenuous exploration of all the possibilities of escape. This often continues long after there is any "objective" possibility of escape. When eventually escape is perceived by the trapped men as impossible, the adaptive response becomes one of conserving the organism, or less frequently, withdrawal (Lucas, 1969). Let us now consider the individual and how he deals with the particular stress of fire. The first process which is undergone by the individual is one of threat appraisal.

(v) Threat Appraisal

This process implies that the person must both detect the cues present and recognise them as threatening. Due to the often ambiguous nature of cues in a fire situation, this may not occur immediately. It has been suggested (Dibner, 1958), that greater degrees of ambiguity of stimulus conditions are associated with large stress reactions, even in a mildly stressful situation. However, in reported fire incidents, there frequently seems to be a predisposition to regard such initial cues optimistically. This would seem to be closely related to a conception noted in other hazardous situations which may be summed up by the aphorism "It can't happen to me!". This well-known factor has been reported in other fields of accident research and categorised as "The Personal Invulnerability Factor" (Fox, 1964). It has been suggested that this is a threat-reducing procedure, operating on a "denial" principle, which although giving a suitable name to it hardly serves to explain the phenomenon.

This identification of cues as threatening is of course a dynamic process. The initial cues may be so diffuse as to alert the individual that there is something wrong, without being able to specify exactly what it is. This uncertainty leads him to attempt to verify the nature of the cues.

(vi) Attempts to validate the cues

If the individual is alone he may make some attempt to discover the source of the fire cues, where the smoke or smell of burning originate.

If, however, he is a member of a group then his first attempts at evaluating the threat are likely to be to seek the opinions of other group members as to their assessment of the threat. Since in an untrained group the judgement of one member is unlikely to be any better than another, this process is unlikely to arrive at a true assessment of the threat. After the famous Orson Welles, "Invasion from Mars" broadcast in America (Cantrill, 1947) one of the most striking differences between those who exhibited rational and non-rational behaviour, was in their ability to check the validity of the threat cues. Individuals who showed non-rational behaviour tended to base their judgements on the very vague cues. For instance, an individual looking out of the window and seeing traffic in the street would interpret it as "everyone's fleeing". Seeing a traffic-free street he would interpret it as "everyone's fled". Similarly, Killian (1956) in a study concerned with an explosion at a fireworks factory found that more than half the sample had obtained their information at second or third-hand.

(vii) Definition of the situation

Having appraised and attempted to validate the threat cue, the individual will then attempt to structure the situation, not only in terms of the elements of the perceived threat, but also of his own personality, his previous training and experience. As mentioned earlier, fire cues are often ambiguous in nature, and as most people have little or no experience with the threat of fire, attempts to structure the situation may well start a vicious circle which serves to increase the level of threat. It is clear to the individual that some response is required; but because he cannot define the situation, he cannot initiate any behavioural reaction. This lack of action in a situation which clearly requires it further increases the level of threat, which makes it even more difficult to structure the situation.

(viii) Evaluation of responses

Concomitant with the structuring of the situation must go a decision-making activity, concerned with the evaluation of available responses. The probabilities of certain courses of action having certain consequences must be estimated. Dependent upon this process will be the choice of action by the individual, to reduce the threat to himself. In a fire, these decisions may result in responses which can be interpreted as of the "flight or fight" type. Both escape from the immediate vicinity of the fire, and attempts to extinguish it will result in threat reduction for the individual. Calling for assistance, either from the Fire Brigade or elsewhere, would normally involve some retreat from the immediate area of the fire, with the added threat-reducing possibility of passing on responsibility for taking appropriate action. The success of such threat-reducing response is not necessarily related to the objective level of threat, which may well be increasing. The important element is the individual perception concerning the threat. Withey (op cit) conceives of a perceived balance between the harm-producing stimulus and the resources available to deal with it. When the balance is perceived to favour the harm-producing stimulus, threat is increased up to the limits set by the strength of the motive threatened. When the balance favours the resources, the threat is reduced. Thus he states: "It may well be that a simple ratio of threat to the means for meeting the threat defines the situation". In a fire situation the initial actions may only afford a temporary respite in the level of threat, for instance, if the individual has chosen to "fight" the fire, then as long as it continues to be reduced or contained, he will experience a reduction in threat level. However, if he perceives the fire to be "gaining" on him then he will have to reassess his course of action to compensate for the increased "perceived threat". Similarly in the case of "flight" behaviour, if the initial response is successful (i.e. the individual escapes from the environs of the fire, and leaves the building completely) he may then experience an immediate and drastic reduction in the level of threat. This is a particularly dangerous situation, for if he now reassesses his responses, in the absence of any threat cues, he may consider that he over-reacted to the fire threat, in-so-far as it threatened his life, and the perceived threat may be transferred to belongings or property, with the result that he may re-enter the building, perhaps to be overcome by the fire.

If the initial behavioural response does not succeed in lowering the level of threat then, as in the case of inability to structure the situation, the stress on the individual will increase due to his failure to adapt. Greater effort will be invested in the adaptation responses, and as each is exhausted so will the choice of further action become less selective. It is this situation, where the responses beome more "primitive", that rational behaviour may deteriorate into non-rational, and adaptive responses become non-adaptive, in other words what is often described as "panic response".

2.2 PANIC RESEARCH

As panic appears to occupy a central role in the literature of fire it is perhaps worth examining the concept in some detail. In this century, interest and concern were first expressed about its effects with regard to troops in World War I. Many papers were produced describing features of panic, this literature having been reviewed by Strauss (1944). Earlier accounts of fires (Benzaquin, op cit; Foy and Harlow, op cit), have described outbreaks of panic in lurid accounts. The topic has also been the subject of psychiatric concern (Diethelm, 1932) and medical attention (Stalker, 1940), particularly with regard to the effect of bombing raids upon civilian populations. A comparative evaluation of the reactions of Londoners in 1941 and civilians in the Spanish Civil War was reported by Schmideberg (1942). Inevitably the topic appears in relation to atomic warfare (Caldwell et al, 1951). Quarantelli (1954 and 1957), using the data collected by the NORC (Dill, op cit), examined the nature and conditions leading to panic. He conceives that such behaviour arises in response to three determining conditions, a definition of possible entrapment, a perception of collective powerlessness and a feeling of individual isolation in a crisis. The concept of entrapment has also been mooted by Foreman (1953), although he places the emphasis rather differently in stating that, "panic develops only when possible avenues of escape are evident", contrasting this with earlier notions that panic arises when a person is completely trapped in a dangerous situation. A more analytical approach to the study of panic was undertaken by Bryan (1958). In studying an actual incident involving a fire, he attempted to relate certain measured variables to manifest behaviour. Perhaps his major finding was that the behaviour of trained personnel appeared to be very similar to that of untrained personnel. This conflicts with the results of Hammerton and Tickner (1968) who found that training has a significant effect in reducing the decrement produced by anxiety in a skilled task. In their investigation, however, the skilled task was not related to the anxiety-producing agent. Other findings from Bryan's study throw doubt on the long-held belief that in threatening situations people invariably attempt to leave the building by the doorway through which they entered. The effectiveness of exit lights in drawing attention to exits is also questioned. This particular feature does not appear to have received sufficient attention from human factors specialists, although two reports from the US Navy (Edmonds et al, 1968 and 1969) do set out specific recommendations for egress from ships.

The first laboratory investigation of "panic" behaviour was performed in 1951 (Mintz, 1951). In this experiment a number of cones with strings attached were inserted into a narrow-necked bottle. Subjects had to pull the cones out of the bottle under a number of conditions involving a nominal fine and reward system for success and failure. Only one cone could be taken out at a time or the neck of the bottle became jammed. Thus subjects had to cooperate with each other to stand any chance of success. It was hypothesised that "panic" occurred due to the "reward" structure of the system. If cooperative behaviour is once perceived as non-rewarding, by an individual "at the back of the queue", then non-adaptive, competitive behaviour will occur, as it is perceived as the least-disadvantageous response. You will note that on this hypothesis, violent emotional excitement, or fear, is not considered to be variable in determining panic behaviour. The results of the experiment supported the hypothesis, in that under the reward/fine conditions, there was significantly more non-adaptive behaviour, than in the control conditions with no incentives. This experiment has subsequently been replicated with less clear-cut results, and in the light of our knowledge of threat, it would not seem to provide a meaningful analogue of a naturalistic panic situation.

The most interesting attempt to study panic behaviour has been made by Schultz (1966). He starts by offering a definition of the term "panic" making the point that the word has been, and is, often misused in describing the behaviour of people fleeing from danger. In many cases, this flight is the only rational way in which to respond, the critical difference between rational escape behaviour and non-rational, panic, behaviour being in the manner in which we try to effect escape. He defines panic as "A fear-induced flight behaviour which is non-rational, non-adaptive and non-social, which serves to reduce the escape possibilities of the group as a whole". This is a very useful definition although one might quibble with the rather general term, "fear-induced", and also with the assumption that panic is always a group-oriented behaviour. In our earlier consideration of threat, we considered how an individual might reach a situation where his behavioural responses become non-adaptive due to his inability to control the level of threat. So we can conceive of an individual panicking alone, as well as in a group.

In an extensive series of studies, Schultz investigated a number of variables concerned with panic. An experimental situation was used which he considered to approximate conceptually to a theatre fire, in which all the people try to escape through a narrow exit. Subjects were placed in a danger situation, and faced with threatened electric shocks, three times stronger than a sample shock of 50 volts actually given, if escape did not take place within a speficied time period. Escape occurred by operating a lever on the subject panel for 2 seconds. However, only one subject could operate the escape lever at a time. The instructions indicated that if more than one did so, the escape mechanism would jam and no-one would escape.

The situation was so constructed that each subject received information that other members of the group were jamming the escape route in their own efforts to escape. Thus, the subject perceived that the escape route was blocked, at least temporarily. The subject had no way of knowing when the escape route would become unjammed; all the subject knew was whether the escape route was open or closed at the moment.

An alternative method of escape was available to the subject by pressing an emergency button at any time. This released the subject immediately but closed the regular escape route permanently, preventing the escape of the others and assuring their exposure to the electric shock. The pressing of this emergency button was considered to represent behaviour that is non-adaptive from the standpoint of the other group members, in that it prevented their escape. The pressing of the button, then, sacrificed the other members of the group but enabled the subject to escape.

Hence pressing the emergency button in the laboratory and moving out-of-turn in the theatre fire were considered to be analogous behaviours. From the standpoint of total group survival these behaviours are non-social and non-adaptive. Both involve attempts on the part of the individual to save himself at the expense of all others concerned.

The variables investigated included the effect of the following: group size, perceived rate of escape of other group members, knowledge of escape time remaining, reduced subject anonymity, and perceiving that other group members had panicked. None of these produced significant differences in the incidence of panic. Several variables, however, produced non-significant trends in the direction of increasing the panic response. These were: increasing the level of threatened penalty for failure to escape, increasing the degree of subject anonymity, and introducing intense visual and auditory stimulation. Using the Cattell 16-PF test it was found that panic responders were significantly more sensitive, effeminate, dependent, hypochondriacal and anxious than those who did not exhibit the panic response. A second series of experiments (Schultz, 1968) used similar apparatus, but altered the experimental situation slightly, in that, instead of being separated in the cubicles, subjects entered the laboratory in groups of five and were seated in a row separated by partitions. The incidence of the "panic" response was investigated as a function of group composition and personality variables. No significant differences in panic response were found between the following: male versus female groups, females from two different subject populations, and mixed-sex versus single-sex groups. Furthermore, there was no significant difference in responses between a group of Naval reservists and a group of male college students, although within the Naval group it was found that the older, longer-service men demonstrated a marked, though non-significant reduction in panic responses compared with the younger shorter-service men. Male subjects who panicked scored significantly closer towards the unstable dimension of the stable/unstable scale of the Maudsley Personality Inventory developed by Eysenck.

The actual incidence of the "panic" response varied between 17% and 42% over the groups, in other words between one-sixth and two-fifths of the subjects demonstrated a willingness to save themselves at the expense of their fellow group members. A second general finding of considerable interest is that some subjects exhibited the "panic response" very early in the experimental situation, for instance nearly 20% of one group pressed the "escape" button within the first 3 seconds. These individuals did not appear to try and use the regular escape route in cooperation with the other group members, but "panicked" almost immediately.

A very similar series of experiments was conducted by Kelly et al (1965). The main findings were that

(a) As threatened penalty for failure to escape increases, the percentage of persons who succeed in doing so declines.

(b) As group size increases, the percentage decreases. This may also be stated as an increase in the time required per escape with increasing size.

(c) The availability of a distinctive response for the public expression of confidence greatly increases the percentage of persons who succeed in escaping.

A criticism which could be levelled at these experiments is that they in no way took account of differences in social structure of the groups, which is considered to be a particularly important variable in real-life situations. The groups of subjects in these experiments would more correctly be described as "collectives" (Bryan, 1970). A further important point is that their opportunities for communication were either very low or non-existent. Let us examine these variables, social structure and communication. If we consider two groups of individuals, say a football crowd and a military unit, it is clear that we could much more easily describe the military unit in terms of relationship of the members to each other. The expectations, duties, obligations, responsibilities, courses of action in a given situation are very clearly defined by a set of rigid rules. In contrast, the football crowd has little or no established hierarchy and is only a temporary congregation of individuals who have gathered for one particular purpose. Between these extremes of "social structure", the casual, unorganised crowd and the formal organised unit, one can conceive of all groups having their own "structure", which if we had techniques sensitive enough, we could measure and quantify. As it is, we can compare in a general way the "structuredness" of groups and identify some of the variables which affect this characteristic. Clearly such things as the training of a group, the number in it, the presence of family or friendship ties, the establishment of leadership figures, formal areas of responsibility and lines of communication between group members are all of importance in determining the structure of the group. Some experimental investigations with relevance to a fire situation have been conducted in this area and they will be briefly described.

2.3 FIRE SIMULATION RESEARCH

The first study, which was carried out in 1941, was an attempt to study the differences between "organised" and "unorganised" groups in situations intended to produce "fear" (French, 1941). Eight organised groups composed of athletic teams were compared with eight unorganised groups of students who were not acquainted with each other. Each group contained 6 members. After a 45 minute session which was intended to produce frustration, by working on insoluble problems, each group was left alone in the experimental room to fill out a questionnaire. The doors to the experimental room were secretly locked and smoke was made to seep under one of the doors. After the group discovered the smoke, a fire siren was sounded in a distant room to increase the illusion of a realistic fire situation. The behaviour of the groups was recorded by observers behind one-way screens, descriptions written afterwards by the subjects and recordings made of verbal behaviour.

The behaviour of the groups varied from apparently genuine fear to fairly complete scepticism or belief that the situation was a hoax. However, all the members of a group tended to react in the same way so that variability within the groups was significantly less than that between groups. The interaction of differing individuals within a group produced a "group atmosphere" which seemed to largely determine the reaction of all members of that group. Interestingly, the organised groups were definitely more frightened than the unorganised groups; however the validity of this conclusion is somewhat reduced because the two sets of groups were not matched for other factors such as educational ability and socio-economic class. Nonetheless it seems that the organised groups were not inhibited in their expression of fear to the same extent as the unorganised ones. In a different context this aspect of inhibition is illustrated by a recent study which utilised a very similar experimental situation (Latane and Darley, 1968).

Inevitably in this study, the subjects were once again college students. (It has been estimated that some 75 to 80% of the experiments conducted in psychology are conducted with college students - subjects who clearly do not represent the population at large.) The students were placed in an experimental room, ostensibly to complete a questionnaire. Smoke was then introduced into the room through a small vent in the wall. The smoke was injected into the room for the entire experimental period until by the end of the experiment, the vision was totally obscured by the amount of smoke present. If the subject left the room and reported the smoke the experiment was terminated. However, if the subject had not reported the presence of the smoke after a 6 minute interval from the time he first noticed it, the experiment was considered completed. The results of this experiment were extremely interesting. Subjects in the room alone reported the smoke in 75% of the cases; however, when 2 passive confederates were provided for each subject, only 10% of the groups reported the smoke. When the total experimental group consisted of 3 naive subjects, in only 38% of the groups did 1 subject report the smoke. Of the 24 persons involved in the eight naive groups, only 1 person reported the smoke within the first 4 minutes of the experiment. However, 55% of the lone subjects had reported the smoke within 2 minutes, and within 4 minutes, 75% of the subjects had reported the smoke.

It was reported that the perception of the smoke was apparently delayed by the presence of other persons, with the median time for noticing the smoke being 5 seconds when alone compared with a median time of 20 seconds for both of the group conditions. The delay in noticing the smoke undoubtedly reflects the constraints which persons accept as being imposed upon their behaviour in public places. These experimental results demonstrate quite clearly the influence of a small group on an individual's behaviour, since in the passive confederate group only 1 of the 9 subjects involved reported the smoke. The behaviour of the naive subjects in the passive confederate conditions was described in the following terms: "The other nine stayed in the waiting room as it filled up with smoke, doggedly working on their questionnaire, and waving the fumes away from their faces. They coughed, rubbed their eyes, and opened the window, but they did not report the smoke".

The explanations given by the subjects who reported the smoke, and those who did not report the smoke, as obtained in the post-experimental interview are reported below.

Subjects who had reported the smoke were relatively consistent in later describing their reactions to it. They thought the smoke looked somewhat strange; they were not sure exactly what it was or whether it was dangerous, but they felt it was unusual enough to justify some examination, for example, "I wasn't sure whether it was a fire but it looked like something was wrong" and "I thought it might be steam but it seemed like a good idea to check it out".

Subjects who had not reported the smoke also were unsure about exactly what it was, but they uniformly said they had rejected the idea that it was a fire. Instead, they hit upon an astonishing variety of alternative explanations, all sharing the common characteristics of interpreting the smoke as a non-dangerous event. Many thought the smoke was either steam or air-conditioning vapours; several thought it was smog, purposely introduced to simulate an urban environment!

It is suggested that during the interpretation of the ambiguous threat cues, the individual is particularly susceptible to the behavioural reactions of other group members. If those around him remain passsive and appear to interpret the situation as being a non-emergency, the individual will tend to have his interpretation modified by this social-inhibiting factor, and behave accordingly. There are three important points arising from this experiment. Firstly, the actual perception of cues may be delayed by the presence of strangers. Secondly, the responses of an individual are closely related to his perceptions of how others are responding. And thirdly, the mere presence of others seems to reduce the likelihood of responding to a threat cue, since if an individual is alone when an emergency arises then he is solely responsible for dealing with it. If others are present, particularly strangers, the individual may feel that his own responsibility for taking action is reduced. It is interesting to note that this "diffusion of responsibility" does not seem to be a function of group size. With regard to the second point mentioned, earlier experiments by Hudson (1965) had demonstrated the important nature of perception of the reactions of others in stress situations. In these experiments a group of college students attending a lecture were distracted by recorded sound of explosions, sirens, aeroplanes and shouting from outside. The results showed a wide range of emotional responses to such distracting and threatening stimuli. Individuals in the situation rapidly developed interpretive hypotheses concerning the stimuli. Where these hypotheses were in conflict anxiety was observed to increase. The more anxious subjects in the group, perceiving others around them as anxious, thus developed cognitive support for their apprehensions.

Returning to our consideration of threat, Wherry and Curran (1966) propose an interesting model for the generation of what they choose to call "Anticipatory Physical Threat Stress" (APTS). This model has much in common with Withey's (op cit) conceptualisation of the mechanisms of stress generation. The APTS is conceived as being a function of three components, the perceived probability of the event, the perceived proximity of the event and the perceived unpleasantness of the event. An initial experiment controlling these three factors demonstrated the feasibility of the model and established that even when the amount of threat is carefully equated for all subjects, some will be more susceptible that others. This result is in accord with the findings of Glickstein et al (1957) who have distinguished anxiety-prone subjects by analysis of heart-rate during a stressful situation. Such individuals were disposed to interpret any strange situation as threatening, and consequently exhibited high heart-rates throughout the experiment, without the characteristic peaks, displayed in response to the most threatening incidents, of the non anxiety-prone subjects. Other findings from the Wherry and Curran Study were that mild stress levels can improve performance whilst greater amounts cause deterioration, a result which is explicable by the concept of arousal (Welford, 1962), and that previous experience in the experimental stress situation had a significant effect upon subsequent test behaviour. The results suggested that confirmation of expectations about the occurrence of a threatening event will reduce performance deterioration in subsequent situations. They also indicate that less deterioration would be expected from individuals who had previously been exposed to high threat levels. The authors point out the crucial role of perception in threat appraisal. Earlier, Kilpatrick (1957) had hypothesised concerning perception in extreme situations drawing upon findings from basic laboratory research. His main thesis was that under stress there is a tendency to isolate oneself from immediate input and to perceive and act in terms of a stable perceptual construct which has proved reliable in the past. Feedback of evidence that these perceptions are inappropriate fails to correct this tendency. If a dominant percept has been established, all happenings may be related to it, thus for instance, the sound of a tornado may be interpreted as that of a train. In the absence of reliable guides from past experience for perceiving or acting, suggestibility is high, and during a period of perceptual conflict extraneous cues are often seized upon as a means of resolving conflict.

Furthermore he argues that the most effective method of accomplishing perceptual reorganisation is through action by the perceiver, mere intellectual knowledge may be insufficient.

2.4 DISCUSSION

We have not attempted to review the whole field of stress research. An enormous volume of research has been performed within the overlapping areas of conflict, frustration, defence, emotion, anxiety and disaster. A continuing problem in the field is that of terminology and definition. The subject matter of stress research has included such areas as

(a) The ability of man to withstand changes in his normal environment, such as sleep deprivation, isolation, accelerative forces, changes in temperature, humidity and others.

(b) The reaction of subjects to unpleasant social or ego-damaging events, such as failure in examinations, ridicule by authority and harrassment during tasks.

(c) The capacity of man to meet unusually high demands on his ability, for instance, by setting tasks which demand very complex responses.

(d) The effect on human behaviour of the threat of the occurrence of disturbing circumstances,such as unpleasant social or ego-damaging events.

(e) The effect on human behaviour of the threat or anticipation of actual physical harm, such as exposure to some physical danger.

The term "stress" in itself may be used to refer to behaviour itself, to the stimulus causing the behaviour, or to the situation in which it occurs. In many cases the stimulus is only defined as a "stressor" in terms of the individual response to it. In other words it is often not known to what degree an individual will find a stimulus "stressful", it is merely inferred that it will be so and an attempt made to confirm this inference by observing some behavioural or physiological reaction, which is thus defined as a "stress response".

With some exceptions the degrees of stress that are dealt with in most experimental situations may be considered mild (Lazarus, op cit), and therefore are not necessarily relevant to levels of stress which may be represented by a fire situation. We have seen that for a large percentage of people, fire represents the most fearful prospect of all (Sales Research Services, op cit).

2.5 A NOTE CONCERNING THE ETHICS OF SOCIAL EXPERIMENTATION

In terms of the whole population, fires in which people are involved are comparatively rare events. Consequently any attempts at direct observation of behaviour seems likely to prove unproductive. Is it possible then, to simulate fire conditions? We have seen that there have been isolated attempts to simulate the threat conditions implicit in fires. However the implications of such studies have recently been appraised in terms of their ethics and methodology. We have instanced some studies in which the aim of the experiment was to induce high levels of stress in the subjects. If this aim was not achieved, then the experiment would have been considered unsuccessful.

Other experiments have gone even further. In one, an experiment designed to study the establishment of a conditioned response in a situation that is traumatic, but not painful (Campbell, 1964), a drug was used to induce a temporary interruption of respiration in the subjects. The experimenters emphasise that "This has no permanently harmful physical consequences, but is nonetheless a severe stress which is not in itself painful ..." The subjects' reports confirmed that this was a "horrific" experience, and all the subjects in the standard series said that they thought they "were dying". The subjects, who were volunteer male alcoholics, were not previously warned of the effect of the drug. In another study conducted by the American military (Berkun et al, 1962), a number of experimental situations were used to convince the subject that his life was in danger. In one situation, the subjects were passengers aboard an apparently stricken plane which "was being forced to ditch or crash land". In another, the subject was led to believe that he was responsible for an explosion which "seriously injured another soldier".

It is suggested that these, and other behavioural experiments involve potentially harmful psychological stress to subjects who are rarely, if ever, informed of this possibility. This might be particularly so in the case of nervous, anxious or other sub-clinically unstable individuals. Yet subjects appear never to have been examined prior to the experiment in an attempt to protect such people. If a realistic attempt were made at simulating a fire situation, the dangers might not only be psychologically damaging. One can envisage subjects suffering real physical harm in attempting escape activity. In one of the earlier-cited studies (French, op cit), the experiment was abruptly terminated when subjects attempted to break down a door. The corollary of this, is that we cannot simulate the real-life threat of a fire situation for ethical reasons. If, however, we remove the element of threat implicit in real-life fires, then our simulation hardly justifies the term, since we have seen that threat is considered to be a key intervening variable.

Having rejected direct observation and simulation as possible methods of study, we will now consider the techniques which are available and which were used in the Present Study.

CHAPTER 3

THE PRESENT STUDY

3.0 THE PRESENT STUDY

As was stated in the Introduction, the aim of the research was to examine and interpret the behaviour of people involved in fires. Up to this point we have discussed the nature of this research problem only in general terms; however we will now turn our attention to the specific manner in which it will be approached.

It is convenient to divide the overall strategy into five areas which must be clarified before research is initiated. Put in the form of very simple questions, these are as follows:

(a) What is the problem?
(b) When defined, can it be answered from existing information?
(c) If not, what information is required?
(d) How may we collect this information?
(e) How may we analyse this information?

Such a schedule is merely an explicit expression, in a particular form, of a general research strategy which could be reformulated in a variety of ways, although the overall principle would remain the same. It will be appreciated that the above list is a conceptual one, and the resolution of each point will bring in its train a series of practical difficulties which require solution. It is also clear that the questions cannot be examined in isolation, since for example, the selection of the most appropriate data collection technique will be dependent upon the nature of the data required, which in turn will be related to the chosen method of analysis. We will briefly examine the rationale of the Present Study under the first four of the above headings. Methods of analysis will be considered in Chapter 5.

3.1 DEFINITION OF THE PROBLEM

The problem as expressed above is intelligible in a superficial sense; however the terminology is open to widely different interpretations. We must establish what we intend the terms to mean and re-examine the problem in this form.

Our first difficulty must arise in considering how we wish to interpret the term "behaviour". Behaviour has been defined as "The total response, motor and glandular which an organism makes to any situation with which it is faced" (Drever, 1952). However for the purposes of study we have limited the term behaviour to mean "The reactions of human organisms which are manifest in covert or overt behaviour which are observable, and capable of being communicated to other individuals".* We have already defined "involved" in the Introduction as "occupying the building at some stage in a fire incident whilst aware of the fire". Whilst this is hardly a rigorous definition, since awareness of a fire is a somewhat indeterminable concept, we will continue to utilise it as a working definition.

Finally we must decide what we mean by fires. Our first constraint is that we are concerned with fires in buildings rather than fires outdoors. Secondly, although we are interested in a broad spectrum of fires, it was felt that the study would be of less value if it was based upon a preponderance of very minor incidents. It was decided therefore that fires would be defined as those which were sufficiently serious to require the attendance of the Fire Brigade. This decision was obviously influenced by considerations to be discussed in Section 3.4.

We have now established a working definition of the research problem, based upon the discussions above, which serves as a starting point for examination of research strategy.

3.2 EVALUATION OF EXISTING INFORMATION

Our brief literature review suggested that there were two particular areas of previous work which might be of relevance to the research problem, namely disaster research and studies of stress. The studies discussed in Chapter 2 represent only a small percentage of these broad fields which was judged to provide useful data or concepts in the present case. Even so, it must be clear that the majority of this work is only peripherally related. This statement is considered to be justified for a number of reasons. Firstly, it is recognised that the nature of the threat imposed by fires in buildings is a very specific one, carrying with

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* It is accepted that any definition of the term "behaviour" will be open to argument when stated briefly, as here. The description presented was adopted as a working definition.

it the hazards of reduced visibility, breathing difficulties, heat, noxious fumes, and perhaps most potent of all, the possibility of entrapment. Whilst on the one hand we have this specific threat, on the other, we must realise that most fire incidents are relatively minor in terms of the whole community, involving as they do, perhaps less than 10 people. In contrast, the majority of disaster studies have concentrated on events which involve much larger numbers of people. The completely different scale of these studies must make us extremely cautious regarding the applicability of the findings. A third important point is that whilst fires often involve only small numbers of people, those involved are frequently members of a family. Plainly this may have some influence upon their behaviour, although it is a factor not reproduced in labaratory studies of stress behaviour.

Before finalising the decision to collect data, one further area of knowledge was explored, that of official data on fires. Official statistics for fires in the United Kingdom are compiled from information supplied by Fire Brigades. Each fire incident attended by a Fire Brigade is the subject of an official form, Form K433 (see Appendix 3, p.323). Examination of this form reveals that little or no behavioural information is included in its content. It is clear therefore that the officially-collected data has no value in terms of studying the reactions of people to fires. The decision was therefore confirmed that study of the research problem would require collection of data from fire incidents.

3.3 NATURE OF THE INFORMATION REQUIRED

Consideration of the problem suggests that information on behaviour in fires is potentially available from two sources, either from the "participants" in the fire, or from what we might class as "observers" of the fire. In this latter category would be included firemen, policemen, ambulance-men, newspaper reporters and bystanders. Clearly the nature of the information gained will be largely dependent upon which group provides it. One major difficulty which would arise from relying solely on observer reports would be that they will only see part of the events, either because they are not intimately involved in the dangerous aspects of the situation (as would be the case with bystanders or newsmen), or because at the time of the fire, their primary responsibility is the saving of lives, rather than the objective observation of behaviour (in the case of firemen, policemen and ambulancemen).

In view of this, it was thus decided that in terms of collecting information on behaviour, reliance would be placed upon the reports of the participants themselves. Whilst the building occupants might be in the best position to describe their actions, it is unlikely that they could adequately describe the characteristics of the fire situation. For this purpose the expertise of Fire Brigade personnel clearly has no substitute, and it was therefore intended that behavioural data from those involved would be supplemented by information concerning the nature of the fire, provided by the firemen present at the incident.

There remains one further point to be established, namely the "level" of the information to be collected. Since all field research is constrained by the time and resources available, it is never possible to collect all the information about all the cases. There thus arises the problem of establishing a compromise between the level of detail collected about each case and the number of cases in the sample. In some instances the nature of the particular research problem will indicate how this compromise should be reached; however this is not the case for the present research problem. In view of the paucity of previous research it was not known how much detail it would be necessary to record concerning behaviour, nor, prior to undertaking data collection, was it known how large a sample would be possible. This question regarding intensive/ extensive study was therefore deferred until a later stage, although in the planning phase, the resource constraints indicated a small scale, intensive study.

3.4 POSSIBLE METHODS OF DATA COLLECTION

Since fires are comparatively rare events it is necessary to separate the data collection system into two parts as follows:

(i) A Notification system

The purpose of this system is to provide information on the occurrence of the event to be studied, namely a fire in a building in which people were involved.

(ii) A Data collection system

The purpose of this system is to collect data on the nature of the building, the fire, the occupants and their behaviour.

Since we have established that the five incidents to be studied should be those which required Fire Brigade attendance, it is clear that the Fire Brigade themselves would provide the most comprehensive notification system. Thus the initial plan for the method of data collection conformed to the following outline:

(a) Establish contact with Fire Brigades, which were to act as a notification system for the occurrence of fire incidents.

(b) Data collection concerning the building occupants and their behaviour to be undertaken by the investigator at the scene of the incident by means of interview.

(c) Data collection concerning the nature of the fire and the building to be recorded by the Fire Brigade at the time of the fire.

A Pre-Pilot study was undertaken based upon the above schedule.

3.4.1 THE PRE-PILOT STUDY

Six Fire Brigades within a 40-mile radius of Loughborough were contacted and agreed to participate in the Pre-Pilot Study. The purpose and nature of the study were explained to senior officers. It was suggested by them that since dwelling fires are so numerous, including these within the study might overwhelm the capability of the Fire Brigade to act as a notification system. It was therefore agreed that in the initial stage the study would be restricted to fires which occurred in high-rise flats, and otherwise in non-dwelling occupancies. A system was arranged whereby when a "fire of interest"* occurred, the investigator would be notified as soon as possible. He would then travel to the scene of the incident and interview those involved. Details of the fire and building were to be recorded by the Fire Brigade officers at the time of the fire.

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* As defined by the investigator, "Fires in the types of building outlined previously which involve people, that is, people were present in the building at some stage of the incident".

This system was in operation for a period of 4 months; however it became clear that it was not operating as intended, and was eventually halted for a number of reasons.

(i) Small numbers of incidents

Within the geographical areas covered by the 6 participating Brigades, only a relatively small number of fires of interest occurred. Six incidents were visited.

(ii) Administrative

Whilst every effort was made to discuss the working of the system with the personnel concerned, it became clear that the difficulties associated with changing Fire Brigade shifts, the different times of incidents and establishing telephone contact, the investigator was only notified of a small proportion of the potential incidents.

(iii) Time factors

Due to the difficulties outlined in (ii) above, in practice the investigator arrived at the scene of the incident from a few hours after the fire to up to 5 days afterwards. Both periods were disadvantageous. Arriving at the scene of the incident soon after the fire occurred, in no obvious official capacity, caused difficulties with police, firemen and participants. The police and fire-personnel were concerned that the investigator should not hinder the prime purpose of their presence at the incident, whilst the occupants often found it bizarre that someone should be interested in a detailed account of what they did. If the period of time was longer and fire itself extinguished, residents of high-rise flats often went to stay with relatives, whilst the occupants of other buildings had frequently dispersed. In both cases of course, tracing those involved then became extremely difficult. A further problem was that when the elapsed time between incident and interview was days rather than hours, the interviewee had time to integrate and rationalise the experience, and the impression was gained that they tended to describe their actions in the best possible light. This is a natural human tendency, however, in conjunction with the possible lapses in recall which would occur over this period, the validity of the resultant interview was therefore questionable.

(iv) Lack of cooperation

An underlying assumption of this method of data collection is that those involved will be prepared to talk to the investigator. Unfortunately this assumption proved optimistic at several incidents, particularly in the case of public buildings. In hotel, cinema and factory fires it proved impossible to interview staff members or trace guests due to the attitude of the management. In these cases, the occurrence of a fire was perceived by managers as reflecting badly on their own competence, and for which they would be held responsible. They therefore wished to play-down the incident and would not cooperate in anything which might appear to increase its importance.

The net result of the Pre-Pilot Study indicated that both the notification system and the data collection system had failed to fulfill their intended purpose. Consideration of the failings of the study suggested that the major problem arose due to the investigator assuming the role of prime data collector. However the intended nature of the data, that is, detailed interviews of fire participants, was contingent upon this arrangement. It was clear therefore that both the form and method of data collection required revision.

3.4.2 THE PILOT STUDY

Following discussions with two Fire Brigades, it was decided that using Fire Brigade officers at the scene of the incident as initial gatherers of data should be explored. Clearly this strategy involved a fundamental change in the nature of the data collected. As Fire Officers have only a limited time at each incident, the level of detail capable of being collected would thus be constrained. Whilst this might be viewed as a disadvantage, there were a number of clear advantages which would follow from this system. The necessity for a notification system would be erased, and the difficulties in administration, time factors and small numbers outlined in Section 3.4.1 would be minimised. In addition it was hoped that the involvement of Fire Service personnel would be helpful with regard to the lack of cooperation mentioned, since they are expected to ask questions regarding the circumstances of the fire.

The two Brigades cooperating in the Pilot Study survey represented different types of property at risk. West Riding Fire Brigade has a large number of mills and general industrial property while Warley Fire Brigade (Birmingham) has one of the largest concentrations of tall flats in the country.

The use of firemen as data gatherers indicated a simple questionnaire approach which could be administered in a short period of time. In fact, two questionnaires were developed, very similar in principle but differing slightly to cater for the different occupancies (see Appendices 4 and 5, p.325 and 329).

The two questionnaires each had 17 questions on them, which were broken down into 6 general areas as follows:

(a) How the person first became aware of the fire
(b) Their position in the building at that time
(c) What they did as soon as they realised there was a fire
(d) If or how they tried to leave the building
(e) If they had any difficulty moving about due to smoke, flames, etc
(f) Where they were when the Fire Brigade arrived.

3.4.3 RESULTS OF THE PILOT STUDY

The survey was conducted over a period of 4 to 5 months. In all, 40 incidents were studied resulting in 92 completed questionnaires. We will only discuss the results briefly since the main purpose of the survey was a technique-proving exercise.

With regard to first awareness of the fire, the most frequent methods by which a person became aware of a fire incident were as follows:

(a)	Was told	(35%)
(b)	Saw flames	(21%)
(c)	Smelt smoke	(18%)

The large percentage of people in (b) above tends to indicate that our sample is heavily weighted in favour of people who actually discovered the fire. This is further indicated by the fact that 41% of the interviewees judged themselves to be "close" to the fire. The first actions were then classified into seven categories as shown in Table 1 overleaf.

TABLE 1. Percentage of individuals' first actions

Category	%
Went to investigate	33
Prepared to leave	10
Warned someone else	20
Enquired if Fire Brigade called	10
Attempted to call Fire Brigade	6
Tried to extinguish fire	13
Nothing	8

Points of interest arising from the above table are the relatively high percentage of people who warn someone else, and the relatively low percentage who attempt to call the Fire Brigade.

A methodological difficulty arose at this point in that it became clear that the action categories assigned on the questionnaire were too restrictive, that is, the range of actions was larger than had been allowed for.

With regard to evacuation of the building, one of the most interesting differences arose, in that in incidents in blocks of flats only 15% of those interviewed attempted to leave the building, while in other buildings 60% of those interviewed attempted to leave.

58% of the interviewees stated that they had no difficulty moving about. As expected, smoke was the most frequent cause of difficulty (in 37% of the cases). Of the people who said they had experienced difficulty moving through smoke, 65% stated that they moved 12 feet or more.

When the Fire Brigade arrived only 8% of the interviewees from flats were outside the building, in contrast to the 45% from other buildings.

Finally, a rather surprising 24% of the people claimed to have been previously involved in a fire incident.

The number of incidents and interviewees was too small to attempt to draw firm conclusions and this also precluded more detailed analysis on many of the questions. However, some interesting trends occurred.

(a) In blocks of flats women were significantly more likely to attempt to leave the building than men ($\chi^2 = 4.5$ (1 df), which is significant at the 0.05 level).

(b) Men moved significantly further through smoke than women ($\chi^2 = 10.2$ (3 df), which is significant at the 0.02 level).

(c) The age of those interviewed appeared to have little effect upon their actions, whether or not they left the building, or the distance they moved through smoke.

3.5 DISCUSSION

The Pilot Study served to demonstrate the feasibility of this method of data collection. In no other way would it be possible to obtain information so close in time to the event. However it was clear from the responses of the Fire Brigades involved, that attempting to restrict the area of study to specific types of building led to much reduced response, since the officers at the scene of the fire had to make a decision regarding whether or not to use the questionnaire. In practice it was much easier to remember to use it at all building fires.

It was also clear that the length of the questionnaires mitigated against their constant usage. Any extension of the technique would require changes in format to reduce the length. This of course placed limits upon the amount of detail in which any particular aspect might be examined; however it was felt that the clear advantages of the technique outweighed any restriction of this nature.

In summary, we can see that due to the constraints imposed largely by the feasibility of the data collection methods, we have moved from an original research strategy which envisaged a small sample of incidents being considered in some depth, to the possibility of a much larger sample of incidents considered in somewhat less detail. Whilst the major part of the study would be based upon data from this large sample, it was also planned to examine a sub-sample of incidents in depth, namely those which involved rescues, injuries or fatalities.

CHAPTER 4

THE FULL-SCALE STUDY: METHOD

4.0 THE FULL-SCALE STUDY: METHOD

The Pilot Study described in Section 3.3 served four main purposes. Firstly, it showed the viability of using Fire Brigade Officers as the primary agents for collection of data on fires and the people in them. Secondly, and as a function of the first point, it demonstrated that the format and perceived length of any questionnaire might have a profound effect upon the response rate. In other words, if the Officers saw the task as long and onerous they simply would not administer the questionnaire. Thirdly, it showed that to maximise response rate, the decision to be made by the Brigade Officer whether or not to use the questionnaire at any given incident must be as simple as possible. Fourthly, it indicated additional factors which should be included in the further studies. The decision was therefore taken to proceed with a full-scale study along the following lines:

(a) Data on fires, buildings, and the behaviour of those involved to be collected at the scene of fire incidents by Fire Brigade Officers.

(b) Questionnaires for this method of data collection to be designed to be as clear, well laid-out, and brief as possible, commensurate with collecting valid and reliable information on the selected variables.

(c) Final selection of variables to be included in the full-scale study to be based upon previous research, pilot-study findings, declared area of interest of the Fire Research Station, advice from the Fire Service Personnel, and practicability of data collection.

(d) The questionnaires to be administered at <u>all</u> building fires.

(e) The study to be conducted by as many Fire Brigades as possible, so as to maximise the number of incidents, and cover a wide range of buildings and fire types.

The procedure adopted for conducting the Full-Scale Study is illustrated in Figure 1. We will briefly elaborate on the major operations summarised in the diagram.

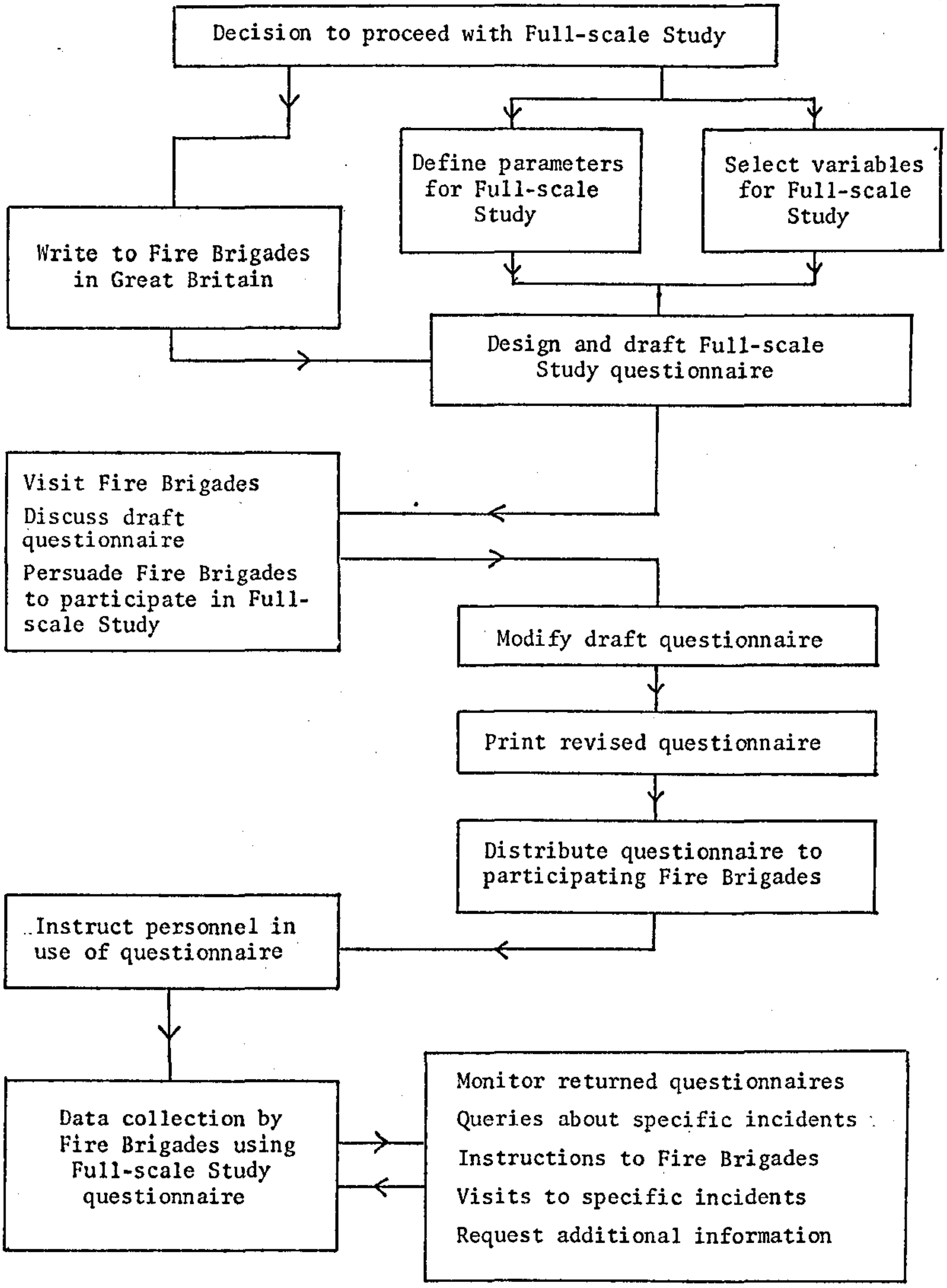

FIGURE 1. Procedure for the Full-scale Study

4.1 PARAMETERS FOR FULL-SCALE STUDY QUESTIONNAIRES

The questionnaires utilised in the Pilot Studies (Appendices 4 and 5) were both duplicated, four-page booklets. Each was used for interviewing one person. The deficiencies associated with this format were numerous. The major ones are outlined below.

(a) Due to their length it was unlikely that more than one person per incident would be interviewed.

(b) They were unwieldy to handle and did not encourage ease of use.

(c) They appeared of rather "amateur" appearance which probably also did not encourage their use.

(d) The questionnaire responses were all "structured", thus not allowing a "picture" of an incident to be built up, nor permitting responses which fell outside the designed range to be entered.

(e) They did not record any other than the barest details concerning the physical aspects of the building and the fire.

In attempting to overcome these, and other deficiencies, various layouts for the Full-Scale Study questionnaires were evaluated. It was decided at a fairly early stage that the final format of the questionnaire should not exceed one page for the physical variables (relating to the fire and the building), and one page-per-person for interviewing individuals involved in the fire.

A further decision which was made was that the layout and typography of the Full-Scale Study questionnaire should appear more "professional", and to this end the advice of a Graphic Designer was sought at an early stage.

4.2 SELECTION OF VARIABLES FOR THE FULL-SCALE STUDY

As was outlined briefly in Section 4.0, the selection of Study Variables was based upon a number of considerations. Clearly the chosen study method precluded an in-depth examination of each incident. It was therefore of critical importance to select the most relevant factors to be included in the final format of the questionnaire.

A preliminary list of variables was drawn up, from which a final selection was made in consultation with Fire Research Station and Fire Brigade personnel. Inevitably the final list reflects, to a certain extent, the particular interests of the researcher, and such a list produced by a research worker from another discipline, or with a different background would not necessarily include the same variables for study.

It was found convenient to consider the study variables under four broad headings: Fire Variables, Building Variables, Personal Variables and Behavioural Variables. There is, of course some overlap between these, and particular variables do not fall neatly into one category. For example, "how a person first becomes aware of a fire", which is a potentially very important factor.

We have seen in surveying the literature that where cues are ambiguous, individuals will invariably make some efforts to verify them; and this will have an important bearing upon their behaviour, and possibly the outcome of the fire.

The "first awareness" is clearly related to the fire, and thus could be classified as a Fire Variable. Alternatively it will vary between individuals and could thus equally well be classified as a Personal Variable. To be exact, it is a "fire-related personal variable". We have in fact included this particular factor under "Personal Variables".

The above discussion is not intended as an apologia, but merely to point out that the placing of certain variables under particular headings is to some extent arbitrary.

The variables finally selected for study are shown below under their particular headings.

4.2.1 FIRE VARIABLES

(a) Severity of the fire as measured by the number of rooms, levels and buildings involved.

(b) Severity of the fire as measured by the number of jets and hose reels used by the Brigade in extinguishing it.

(c) Severity of the fire as measured by the extent of smoke spread.

(d) Severity of the fire as measured by the estimated density of smoke (Fire Brigade estimate).

(e) Position of the fire in the building when it started.

(f) Time of the fire (this was recorded as the time of the first call to the Fire Brigade).

4.2.2 BUILDING VARIABLES

(a) What category of building was involved, in terms of occupancy. Thus buildings would be classified as "Dwellings", "Factories", etc.

(b) What provisions for fire-fighting and emergency escape were provided in the building.

(c) The number of storeys.

(d) The number of people present in the building prior to the start of the fire.

(e) The number of people who left the building during the fire.

(f) The number of people who were rescued by Fire Brigade personnel.

(g) The number of people who were injured in the incident.

(h) The number of people who died in the incident.

4.2.3 PERSONAL VARIABLES

(a) Age and sex of the person interviewed.

(b) How that person first became aware of the fire.

(c) How serious they considered the fire to be immediately they were aware of it.

(d) Their position (floor) in the building.

(e) Whether they worked, or lived, in the building.

(f) How familiar they were with the building layout.

(g) How frequently they had received instruction or training on what to do in case of fire.

(h) Whether they knew a means of emergency escape from the building.

(i) Who was present with them in the building.

(j) Whether they had been involved in a fire incident previously.

4.2.4 BEHAVIOURAL VARIABLES

(a) What was the first, and subsequent actions they took when they realised there was a fire.

(b) Whether or not they left the building.

(c) Whether or not they returned into the building.

(d) Whether or not they attempted to move through the smoke. If they did, how far they moved and how far they could see ahead of them.

(e) Whether or not they had to turn back because of the smoke.

4.3 VISITS TO FIRE BRIGADES

Whilst each Chief Officer of a Fire Brigade (or Fire Master in Scotland) is in the final event answerable to Her Majesties Inspector of Fires at the Home Office, they are in many respects autonomous. It was not possible therefore, to solicit blanket cooperation from Brigades through a Central Authority. (Although of course permission was sought from the Home Office to approach individual Brigades.) Once Home Office permission had been granted, the procedure in persuading the Fire Brigades to participate in the Full-Scale Study followed five major steps which are described below.

(a) Write to the Chief Officer of every Fire Brigade in Great Britain,* explaining the purpose of the study, and asking permission to visit him and discuss the possibility of his Brigade taking part in the proposed study.

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* At the time of the research there were 123 City and County Fire Services

(b) Visit Chief Officers who responded positively to the initial letter. A draft copy of the Full-Scale Study questionnaire was taken for discussion and advice on possible modifications. Permission was sought for personnel under his command to take part in the study.

(c) In some cases the Chief Officer agreed that his Brigade would participate on condition that the personnel who would be directly involved, the Divisional Officers, were prepared to undertake the additional work. This entailed a second visit to these Brigades to discuss the study with the Divisional Officers who were gathered together for the occasion.

(d) Once it was clear that at least some Brigades were prepared to participate, discussions were held with the Fire Brigade Unions to obtain permission for the personnel to undertake the study.

(e) The final visit to participating Brigades prior to the commencement of the study was undertaken to discuss the final form of the questionnaire, instruct personnel in its use, and to answer queries.

The result of this activity was that twelve Fire Brigades agreed to take part in the Full-Scale Study. Fortunately, three of these were the largest Brigades in Great Britain. It was also fortunate that the areas of the participating Brigades were both geographically spread, thus allowing for regional differences, and also represented a wide range of hazards and building types. The actual Brigades who eventually took part in the study are listed in the Acknowledgements.

4.4 MODIFICATION AND FINALISING OF THE FULL-SCALE STUDY QUESTIONNAIRE

In the light of the contact with Fire Brigades discussed in Section 4.3, minor modifications to the draft questionnaire were made. One major point which was established related to the number of potential interviewees it would be possible to include at each incident. It will be recalled (see Section 4.1) that it had been decided that the final format should not exceed one page for the physical variables, and one page-per-person for interviewing those involved. What could not be previously decided was the maximum number of interview pages to be included at each incident. Discussions with Brigade personnel suggested that this number be set at six. It appeared unlikely that Brigade Officers would be at the scene of a fire for sufficiently long to interview more than six people. It was agreed however that should this be the case, then more than one set of questionnaires would be used.

Thus the final arrangement of the Full-Scale Study questionnaire was for six "interview" questionnaires labelled Part 2, recording Personal and Behavioural variables to be attached to a front page, labelled Part 1, on which were to be recorded Fire and Building variables. The final format of the questionnaire is shown overleaf, and a copy of the completed booklet is illustrated in Appendix 6. The brief instructions for the use of the forms, which is incorporated in the heading, was supplemented by printed "Notes of Guidance" (Appendix 7). In addition, once the study had begun, all returned questionnaires were monitored to ensure correct completion, and where necessary, personal visits to the cooperating Fire Brigades were made to correct any errors or ommissions and to re-instruct the Divisional Officers. Where incidents of particular interest occurred, for example a fatality, visits to Brigades were also undertaken to obtain supplementary information.

4.5 DISCUSSION

To summarise this section, we had now developed a more comprehensive questionnaire which would investigate in considerable detail variables under the general headings of Fire, Building, Personal and Behavioural. These questionnaires were distributed to twelve Fire Brigades who would use them to interview people involved in fires at the scene of the incident. The questionnaires were handled by Fire Brigade Officers of at least Divisional Officer grade. All the questionnaires were completed within an hour of the incident having taken place, and in many cases within minutes of the fire having been extinguished. The questionnaires were returned to the investigator at weekly intervals for analysis.

The Behaviour of People in Fires

e are trying to find out if people react differently to fires
different kinds of building. This set of questionnaires is
ncerned with one particular incident and is composed of
/o parts.

rt I, which is about the fire and the building should be
swered by the Fire Brigade Personnel. Part II comprises
e six subsequent questionnaires, which are about people
volved in the fire. The questionnaires in Part II are for use
interviewing six separate individuals who were in the
ilding when the fire was discovered. We are interested in
anyone who was in the building, not only the person who first discovered the fire.

We would therefore like you to interview as many people as possible who were involved with the incident. Both Part I and Part II should be handled by Fire Brigade Personnel, not by the person being interviewed. Where a question is followed by a list of suggested alternatives please tick the box opposite the most appropriate answer. Where a distance estimate is required please circle the relevant number.

Part 1 Information on the Building and Type of Fire

Address

a fire alarm (manual or automatic) provided in the
ilding? . . . . Yes ☐
No ☐

so, was it used? . . . . Yes ☐
No ☐

: fire fighting equipment provided in the building?
Yes ☐
No ☐

so, was it used? . . . . Yes ☐
No ☐

fire fighting equipment is not provided, was any-
ther attempt made to extinguish the fire before the
ire Brigade arrived? . . . . Yes ☐
No ☐

re there any recognised escape routes in the
uilding? . . . . Yes ☐
No ☐

so, were they used? . . . . Yes ☐
No ☐

"No", please specify why not

hat category of building is it? *In general terms, for*
xample – school, block of flats, shop, cinema,
rivate dwelling house, multi-occupancy dwelling,
c.

Date

Time

K433 Report Sheet Number

6 **What is the maximum number of storeys in the building?** . . . . ☐

7 **On which floor did the fire start?**
Basement = –1, ground = 0, first = 1, etc. . . . . ☐

8 **Approximately how many people do you think were in the building when the fire was discovered?**
Please put the number in the box . . . . ☐
Approximately how many left the building during the course of the fire? *If all, write ALL* . . . . ☐
How many people were rescued by Fire Brigade Personnel? . . . . ☐
How many people were injured non-fatally? . . . . . . ☐
How many people were injured fatally? . . . . ☐
How many people were injured (fatally or non-fatally) in escaping the building? . . . . ☐

9 **How many**
rooms were involved in the fire . . . . ☐
levels were involved in the fire . . . . ☐
constructions were involved in the fire . . . . ☐

10 **How many jets were utilised?** . . . . ☐

11 **What was the extent of the smoke spread?**
None . . . . ☐
Confined to room of origin . . . . ☐
Confined to floor of origin . . . . ☐
Spread to floor above . . . . ☐
Even more extensive . . . . ☐

12 **What was the density of the smoke at its worst?**
If, on the scale below, 7 represents the thickest smoke you have ever encountered, and 1 represents very thin smoke, put a cross in one of the spaces which represents the density of the smoke in this incident.

1 ☐ ☐ ☐ ☐ ☐ ☐ ☐ 7

t 2 Information about the Person in the Fire

Male ☐ **Female** ☐ **Age** ☐

How did you first become aware there was a fire?
- Felt heat .... ☐
- Saw flames .... ☐
- Saw or smelt smoke .... ☐
- Heard noises associated with the fire .... ☐
- Heard shouts .... ☐
- Was told .... ☐
- Heard fire alarm or fire engines .... ☐

Something else *please specify*

When you realised there was a fire, how serious did you think it was?
- Extremely serious ...... ☐
- Quite serious .... ☐
- Not at all serious ...... ☐

Which floor were you on when you realised there was a fire? .... ☐

Do you either live or work in the building? Yes ☐ No ☐

How familiar are you with the layout of the building?
Are you ....
- *completely familiar with it* ☐
- *fairly familiar with it* .... ☐
- *slightly familiar with it* .. ☐
- *not familiar with it* ..... ☐

What was the first thing you did when you realised there was a fire?

What did you do next?

and next?

How often have you received training on what actions to take in a fire?
- At least once per month .... ☐
- At least once every six months .... ☐
- At least once every year .... ☐
- Less frequently than once a year or never .... ☐

8 ***Did you know of any means of emergency escape in the building?*** .... Yes ☐ No ☐

9 **Did you leave the building during the fire?** ..... Yes ☐ No ☐
If NO, please pass on to question 10

In leaving did you use
- The normal exits .... ☐
- An emergency exit .... ☐

Some other way *please specify*

Did you leave by ......
- Your own efforts ...... ☐
- With Fire Brigade help .. ☐
- With the help of others .. ☐

Did you return into the building during the course of the fire? .... Yes ☐ No ☐

If you did, for what reason?

10 **What reason did you have for not leaving? Was it because**
- You did not think the fire was serious enough ..... ☐
- You thought you would be safer where you were ... ☐

Some other reason *please specify*

11 **Was there any smoke?** .... Yes ☐ No ☐
If NO, omit the rest of this question

Did you try to move through it? .... Yes ☐ No ☐
If NO, omit the rest of this question

How far did you try to move through it?
Yards .... 0 .... 2 .... 4 .... 10 .... 12 .... 15 .... 20 .... 20+

How far ahead could you see at the time?
Yards .... 0 .... 2 .... 4 .... 10 .... 12 .... 15 .... 20 .... 20+

Did the smoke become thicker? .... Yes ☐ No ☐

Did you have to turn back because of it? ...... Yes ☐ No ☐
If NO, omit the next part of the question

How far ahead could you see when you turned back?
Yards .... 0 .... 2 .... 4 .... 10 .... 12 .... 15 .... 20 .... 20+

12 **Were any of the following people with you in the building during the fire?**
- Your children under 12 .. ☐
- Your children over 12 ... ☐
- Your wife/husband ..... ☐
- Your parents .... ☐
- Some other relative ..... ☐
- Friends .... ☐
- Acquaintances .... ☐
- People unknown to you .. ☐

13 **Have you ever been involved in a fire incident before?** Yes ☐ No ☐

CHAPTER 5

DESCRIPTIVE ANALYSIS OF THE STUDY VARIABLES

5.0 DESCRIPTIVE ANALYSIS OF THE STUDY VARIABLES

In this section it is intended to set out the results of the study in terms of descriptive statistics. This is intended as a scene-setting exercise, prior to the detailed examination of the relationship between the study variables conducted in subsequent chapters. In this preliminary analysis we are merely describing how many fires, buildings, people, etc., were involved.

5.1 THE FIRES

Data was collected from 952 fire incidents. Figure 2 shows how this sample is related to the overall population of "fire incidents".

Unfortunately official Fire statistics are not capable of being broken down into an equivalent population of "fires in buildings in which people are involved". The nearest official breakdown is the much larger "Fires in Buildings". The present sample represents some 12% of this population over an equivalent period of time for the Brigades taking part in the survey (Department of The Environment, 1974).

The time of occurrence of the incident was recorded as the "time of the first call to the Fire Brigade". This was divided into four categories, as shown in Table 2 below.

TABLE 2. Incidents by time (Present Study)

Category	% of incidents
Morning (6 am to noon)	22.4 (213)
Afternoon (noon to 6 pm)	38.2 (364)
Evening (6 pm to 11 pm)	25.4 (242)
Night (11 pm to 6 am)	14.0 (133)
Total	100.0 (952)

Again, comparing this with the official breakdown is a little difficult as the neasrest tabulation is "... Time of Call in Relation to Hazard (in Buildings)". In this table the buildings are categorised

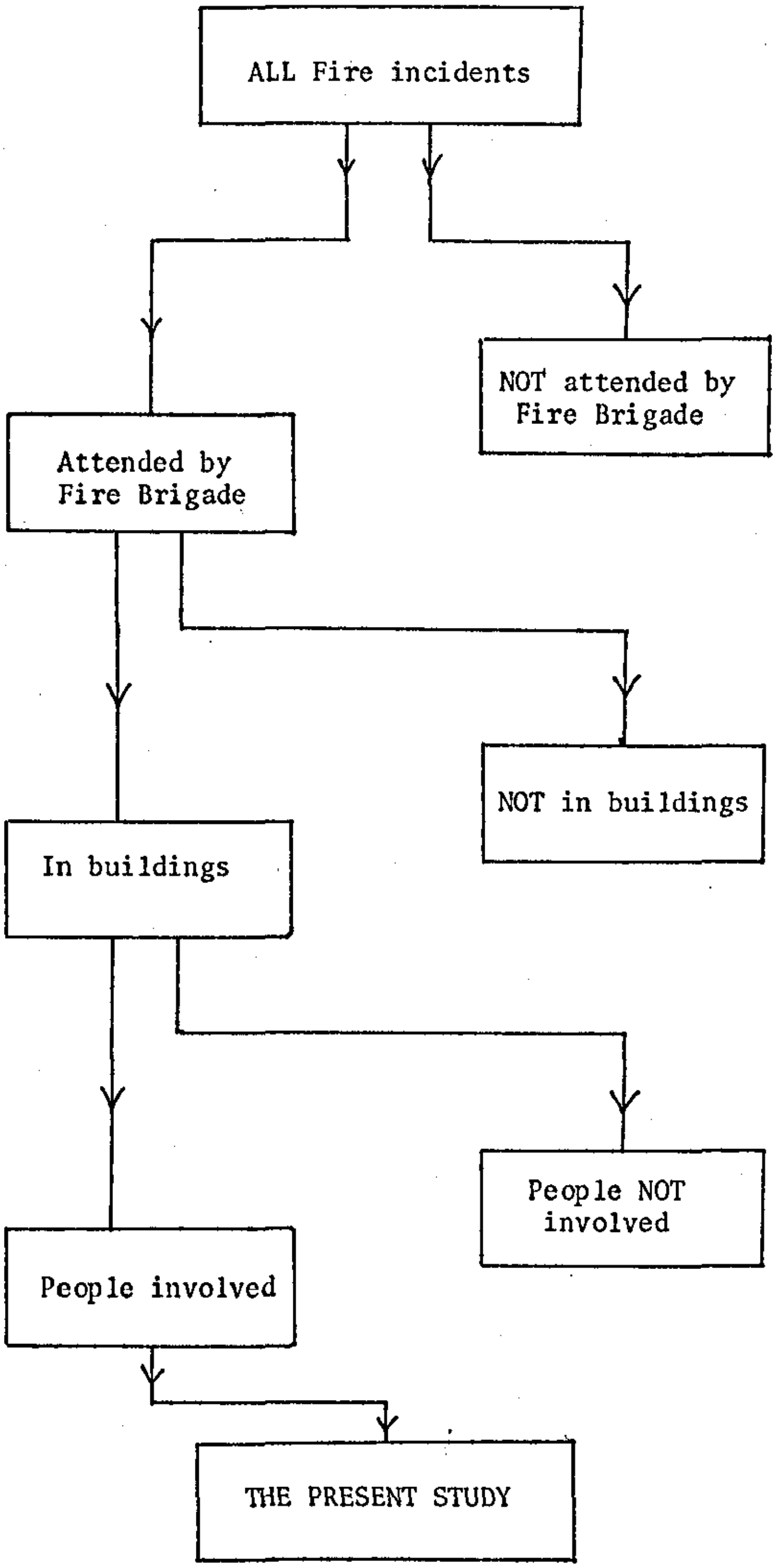


FIGURE 2. Study sample in relation to the population of fire incidents

according to what type of trade or industry, etc., are conducted in them. However, by combining categories into the general headings utilised in this report, we find that the distribution of incidents is as shown in Table 2a below.

TABLE 2a. Incidents by time (official statistics)

Category	% of incidents
Morning (6 am to noon)	19.1 (17026)
Afternoon (noon to 6 pm)	37.5 (33466)
Evening (6 pm to 11 pm)	28.8 (25675)
Night (11 pm to 6 am)	14.6 (13007)
Total	100.0 (89174)

Source: United Kingdom Fire and Loss Statistics 1971 (Dept of the Environment, op cit)

The difference between the frequencies in Tables 2 and 2a are statistically significant ($\chi^2 = 9.35$, 3df significant at 0.025 level). The source of this difference is apparent by inspection, the present study having a greater proportion of fires which occur in the morning, and a smaller proportion in the evening.

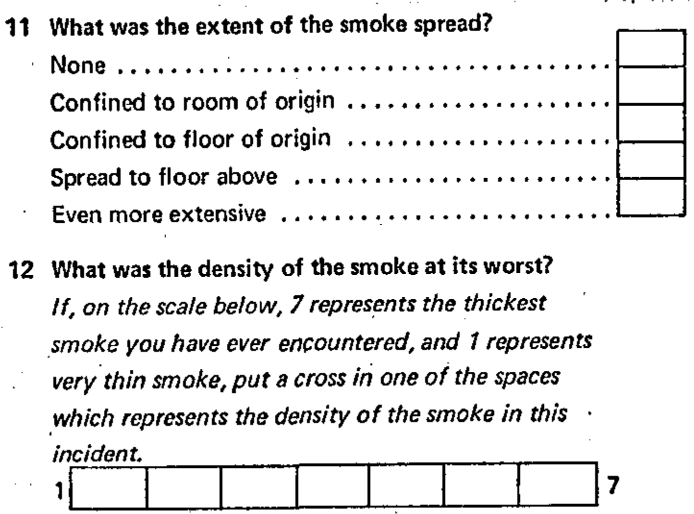
In order to obtain some measure of how severe the fire was, the following questions were asked:

9 How many
rooms were involved in the fire .... ☐
levels were involved in the fire .... ☐
constructions were involved in the fire .... ☐

10 How many jets were utilised? .... ☐

863 (more than 90%) of the incidents were confined to one room (or area) on one level in one building. 269 (28%) of the incidents were sufficiently serious to require at least 1 Jet to be used.

As with Fire Severity, to obtain some measure of the smoke conditions in the building, the Fire Brigade were asked to judge how extensive and how dense the smoke was.



11 What was the extent of the smoke spread?

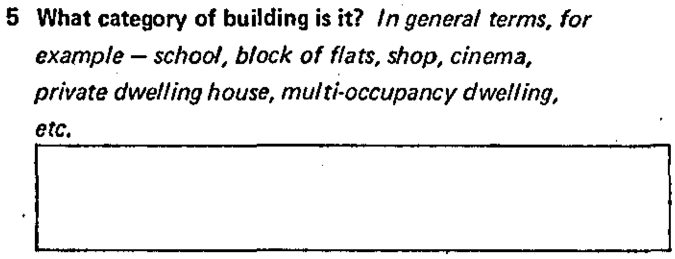
None .... ☐
Confined to room of origin .... ☐
Confined to floor of origin .... ☐
Spread to floor above .... ☐
Even more extensive .... ☐

12 What was the density of the smoke at its worst?
If, on the scale below, 7 represents the thickest smoke you have ever encountered, and 1 represents very thin smoke, put a cross in one of the spaces which represents the density of the smoke in this incident.

1 ☐☐☐☐☐☐☐ 7

The histograms in Figure 3 illustrates the distribution of these measures.

5.2 THE BUILDINGS



5 What category of building is it? *In general terms, for example – school, block of flats, shop, cinema, private dwelling house, multi-occupancy dwelling, etc.*

☐

The incidents were categorised by occupancy as shown in Table 3. The categories are based upon a more detailed breakdown of the Standard Industrial Classification. By combining our sample categories it is possible to derive a comparable classification. Doing this, and again using the sample "Fires in Buildings" for comparison, it would seem that the present sample has proportionately more dwelling houses than the official statistics do, but in other categories it is fairly comparable. We will further discuss this point in Sections 5.5 and 17.1.

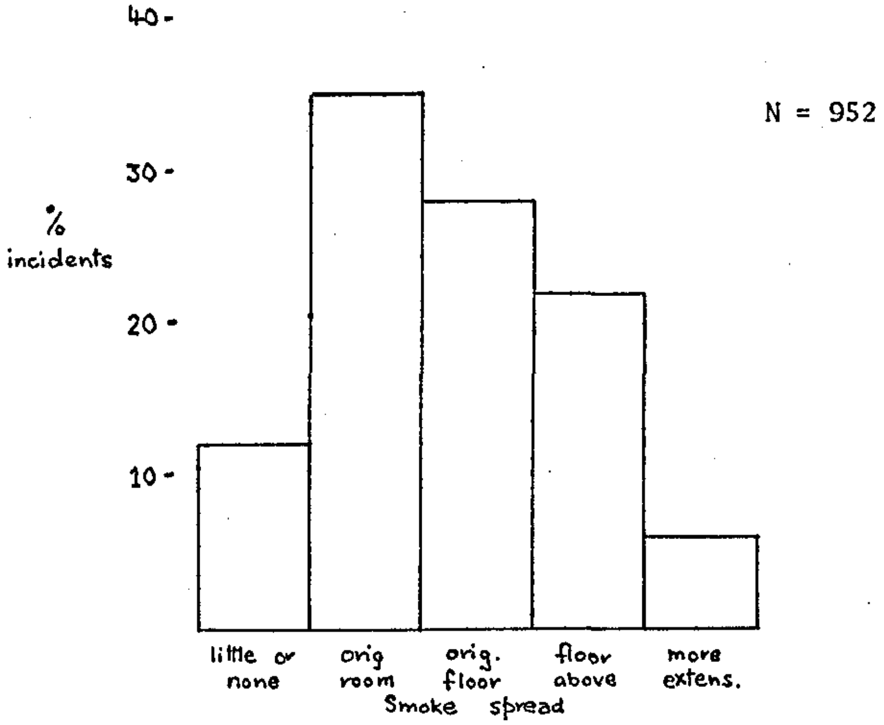


FIGURE 3. Percentage distribution of Smoke Spread

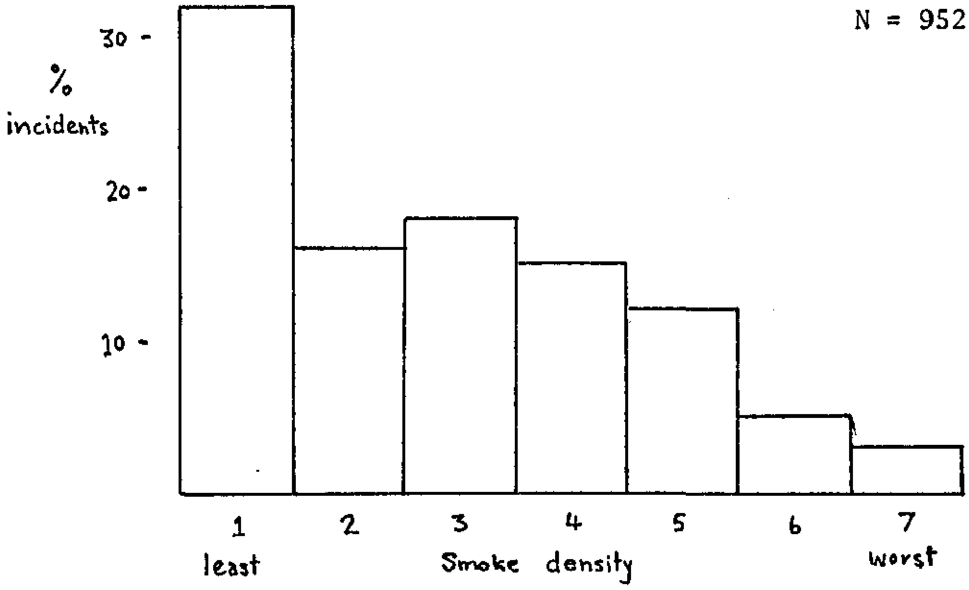


FIGURE 3(a). Percentage distribution of Smoke Density

TABLE 3. Incidents by occupancy

Category	% of incidents
Dwelling house	50.6 (482)
Factory	16.7 (159)
Block of flats	6.4 (61)
Multi-occupancy	4.4 (43)
School	0.7 (7)
Hotel	0.7 (7)
College	0.3 (3)
Shop (unspecified)	6.0 (57)
Public house	1.4 (13)
Fish and chip shop	1.2 (11)
Garage	1.9 (18)
Warehouse/store	1.6 (15)
Cafe/restaurant	1.2 (11)
Launderette	0.5 (5)
Hostel/home	1.1 (10)
Office	0.6 (6)
Flat over shop, etc.	1.3 (12)
Hospital	1.3 (12)
Boiler house	0.4 (4)
Other	1.7 (16)
Total	100.0 (952)

Some relevant information concerning the building was provided in the following questions:

		Response Percentages
1 Is a fire alarm (manual or automatic) provided in the building?	**Yes** ☐ **No** ☐	.... 22 (209)
If so, was it used?	**Yes** ☐ **No** ☐	.... 55 (115)
2 Is fire fighting equipment provided in the building?	**Yes** ☐ **No** ☐	.... 38 (362)
If so, was it used?	**Yes** ☐ **No** ☐	.... 68 (246)
3 If fire fighting equipment is not provided, was any-other attempt made to extinguish the fire before the Fire Brigade arrived?	**Yes** ☐ **No** ☐	.... 55 (324)
4 Are there any recognised escape routes in the building?	**Yes** ☐ **No** ☐	.... 47 (447)
If so, were they used?	**Yes** ☐ **No** ☐	.... 53 (237)
6 What is the maximum number of storeys in the building?	☐	

With blocks of flats representing only 6.4% (61) of the incidents, it is unsurprising that buildings with less than 5 storeys make up more than 90% (857) of the sample. Two-storey buildings were the modal class. True high-rise flats (with 5 or more storeys) represent some 1.7% of the sample (16 incidents).

7 On which floor did the fire start?
Basement = −1, ground = 0, first = 1, etc. .... ☐

Almost 64% of the fires started on the ground floor, 22% on the first floor, 5% on the second, and 3% in the basement. All other values were of 2% or less.

8 Approximately how many people do you think were in the building when the fire was discovered?
Please put the number in the box .... ☐
Approximately how many left the building during the course of the fire? *If all, write ALL* .... ☐
How many people were rescued by Fire Brigade Personnel? .... ☐
How many people were injured non-fatally? .... ☐
How many people were injured fatally? .... ☐
How many people were injured (fatally or non-fatally) in escaping the building? .... ☐

(a) The average number of people per building was 18, however the modal class was only 2 per building. 9% of the buildings were occupied by only 1 person, 53% by 3 people or less, 78% by 10 people or less and 85% by 20 people or less. 2% of the incidents involved buildings in which more than 250 people were present.

(b) In 31% of the incidents nobody left the building. Again the average value of 5 is not very meaningful, the modal class in this case being 1 person leaving (20% of the incidents). Also with high values were 2 people leaving, 16%; 3 people, 9%; and 4 people, 6%. In 95% of the incidents 20 people or less left the building.

If we examine what percentage of people left the building we find that, as already stated, in 31% of the incidents no people left and in 49% everybody left; these two categories accounting therefore for 80% of the incidents. In 4% of the incidents, half the people left, the remainder being made up of groups with less than 2% in them.

(c) Over all the incidents studied, only 1.6% involved rescues by Fire Brigade personnel. The rescues involving 1 to 4 people accounted for most of this figure, only two incidents involved rescuing 10 or more people.

(d) 6% of the incidents involved non-fatal injuries, 1 or 2 people injured being the largest category.

(e) Seven incidents involved a fatality. In each case 1 person only died.

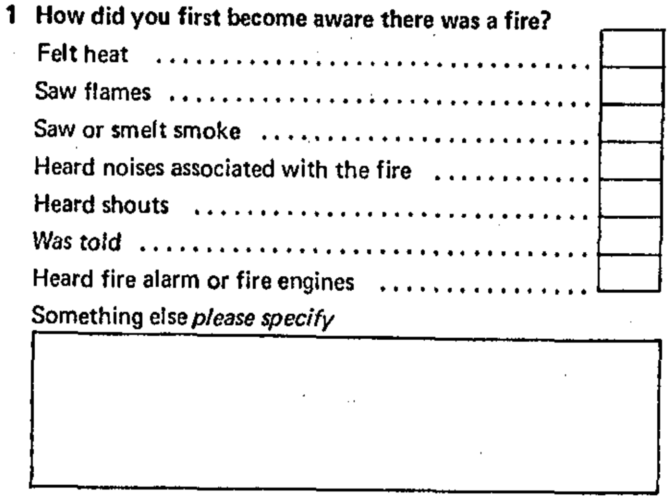
(f) 1.6% of the incidents involved injury which occurred in escaping the building. Most of these involved only a single person.

5.3 THE PEOPLE

From the 952 fire incidents, 2193 people who were involved in them were interviewed using Part 2 of the questionnaire, 1239 men (56.55%) and 954 women (43.45%).

The distribution of ages of those interviewed approximates a normal distribution (Figure 4) although it is skewed to the younger end of the scale. The modal age group is 30 - 39 years.

How a person first became aware of the fire was considered to be a possibly important variable. People close to the fire would receive very clear cues indicating the presence of fire. Those some distance away would receive cues of a more ambiguous nature.



1 How did you first become aware there was a fire?

Felt heat .... ☐

Saw flames .... ☐

Saw or smelt smoke .... ☐

Heard noises associated with the fire .... ☐

Heard shouts .... ☐

Was told .... ☐

Heard fire alarm or fire engines .... ☐

Something else *please specify*

☐

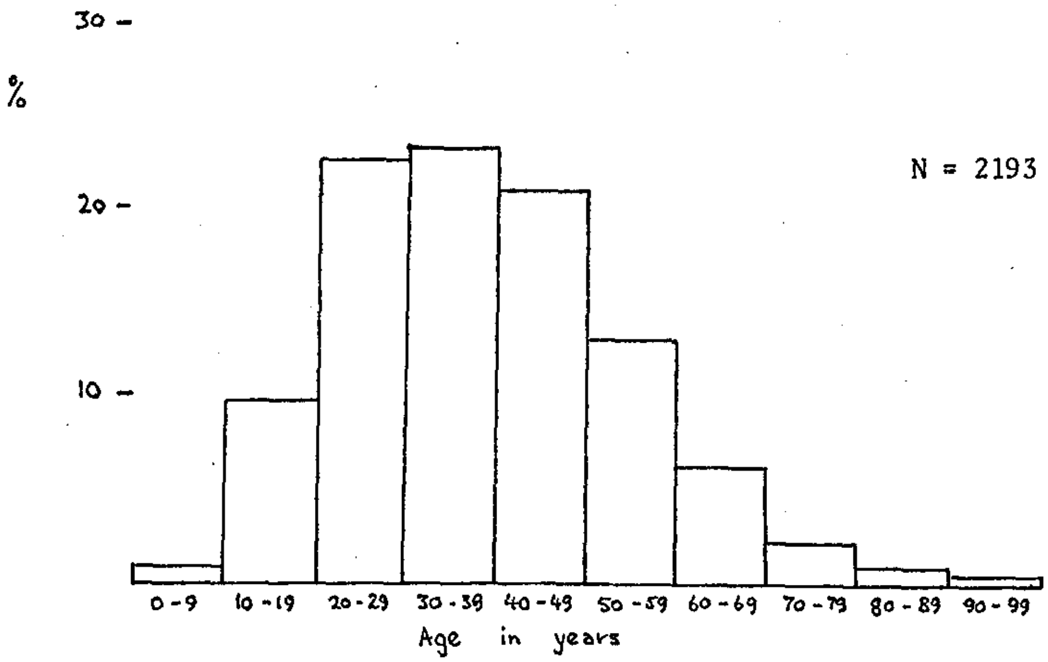


FIGURE 4. Percentage age distribution of interviewee sample

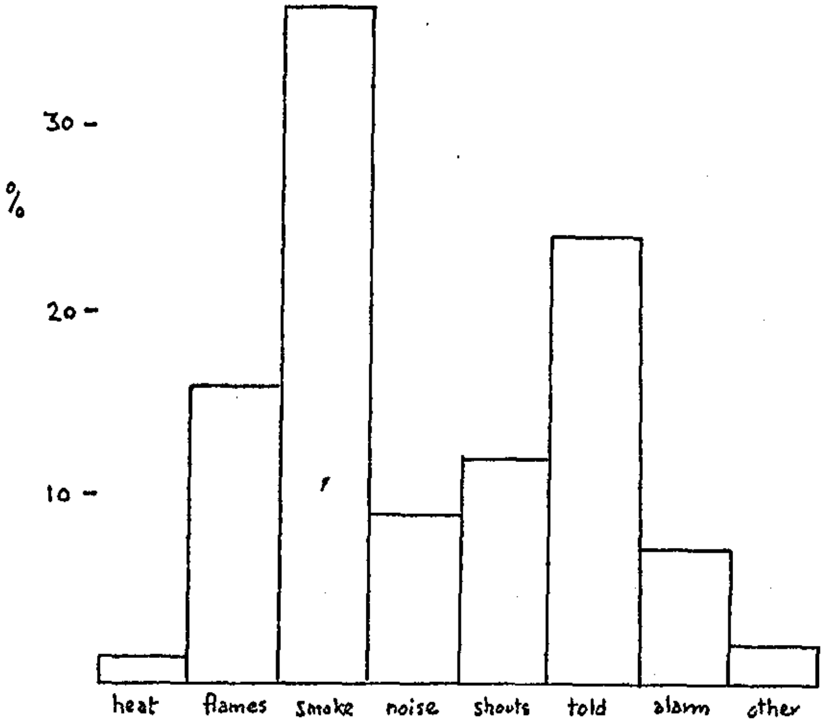


FIGURE 5. Percentage distribution of how people first became aware of the fire (categories not mutually exclusive)

A histogram illustrating percentages in each category is shown in Figure 5. The categories are ordered in a general way on a scale of "proximity" to the fire. The perception of smoke and "being told" are clearly the most frequent cues.

Interviewees were asked for a "seriousness rating" of the fire.

				Response Percentages	
2 When you realised there was a fire, how serious did you think it was?	Extremely serious	☐	....	20.2	(443)
	Quite serious	☐	....	50.4	(1105)
	Not at all serious	☐	....	29.4	(645)
			Total	100.0	(2193)

This question was included to obtain a crude measure of how subjectively threatened a person felt by the fire. From the discussion in Section 2.0, it would in general be considered that high levels of subjective threat are associated with very forceful threat-reducing behaviour, which might well be inappropriate in terms of a specific fire. Furthermore, it has been shown (Wherry & Curran, op cit) that people have individual thresholds for threat. It may be hypothesised that people with low thresholds are responsible for an initial "panic" reaction, or at least for less appropriate behaviour patterns. Clearly, rating a fire as "extremely serious" may be associated with some objective variable, such as high smoke density, or the presence of young children; however these aspects will be explored in a later section. For the present we will merely illustrate the distribution of scale values as shown.

The floor on which the person was when he first became aware of the fire was then recorded. From this was then computed his position relative to the fire. Frequencies and percentages are shown in Table 4.

TABLE 4. Position of fire relative to person

Category		%	f
3 or more floors	below	1.37	(30)
2 floors	below	2.74	(60)
1 floor	below	14.68	(322)
same floor		64.11	(1406)
1 floor	above	13.22	(290)
2 floors	above	1.78	(39)
3 or more floors	above	2.10	(46)
Total		100.0	(2193)

Clearly a large proportion of the people interviewed were on the same floor as the fire.

The following two questions were intended to explore a possible key variable, a person's familiarity with the building.

				Response Percentages	
4 Do you either live or work in the building?	Yes	☐	....	90.0	(1974)
	No	☐	....	10.0	(219)
5 How familiar are you with the layout of the building?					
Are you	completely familiar with it	☐	....	84.9	(1862)
	fairly familiar with it	☐	....	9.6	(211)
	slightly familiar with it	☐	....	2.7	(59)
	not familiar with it	☐	....	2.8	(61)
			Total	100.0	(2193)

The first question was inserted as a lead-in to the familiarity scale. In fact only 10% of the people did not either live or work in the building. The potential importance of familiarity as a key variable was hypothesised on the basis of its likely effect upon such factors as use of escape routes, movement through smoke, and whether or not the person left the building.

It will be seen that a very large proportion of the people were completely familiar with the building. The small proportions in the other categories are perhaps a little disappointing, however it is probably not unrepresentative of people in fires in general.

Another possible key variable was investigated in the following question:

			Response Percentages	
7 How often have you received training on what actions to take in a fire?				
At least once per month	☐	....	5.8	(127)
At least once every six months	☐	....	6.5	(143)
At least once every year	☐	....	9.0	(197)
Less frequently than once a year or never	☐	....	78.7	(1726)
		Total	100.0	(2193)

The possible effect of training frequency upon almost all the behavioural variables is too obvious to necessitate listing.

An extension of this aspect, relating to a person's preparedness for fire, was pursued in the next question.

		Response Percentages	
8 Did you know of any means of emergency escape in the building? .... Yes ☐	....	64.0	(1404)
No ☐	....	36.0	(789)
	Total	100.0	(2193)

Since the earlier-cited definition of panic behaviour requires it to be non-social, the investigation of Personal Variables would be incomplete without consideration of the presence of other people. This aspect was explored in the following question.

			Response Percentages	
12 Were any of the following people with you in the building during the fire?	Your children under 12 .. ☐	....	17.2	(377)
	Your children over 12 ... ☐	....	8.0	(175)
	Your wife/husband ..... ☐	....	20.6	(452)
	Your parents .... ☐	....	7.0	(154)
	Some other relative ..... ☐	....	9.5	(208)
	Friends .... ☐	....	24.7	(542)
	Acquaintances .... ☐	....	36.1	(792)
	People unknown to you .. ☐	....	9.7	(213)
		Total	100.0	(2193)

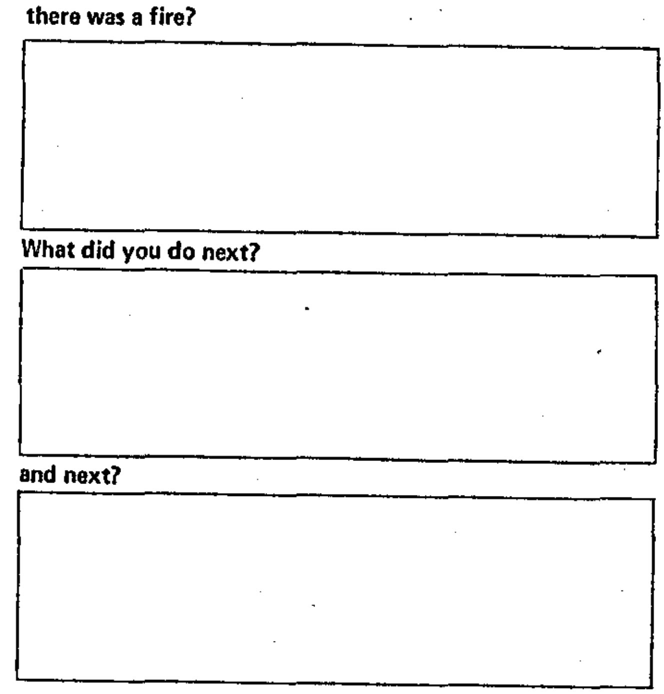
Again the categories are ordered in a general way on a "closeness of relationship" scale, although of course it is not a true scale as the categories are not mutually exclusive. This also explains why the percentages shown above sum to more than 100.

The final Personal Variable considered was whether or not the person had been previously involved in a fire incident. The term "fire incident" was not defined, nor was the time scale indicated, which may account for the surprisingly high proportion of nearly 30% (656) of the interviewees claiming to have been previously involved. As the Pilot Survey reveals a figure of 24%, it may be hypothesised that the chances of being involved in a fire incident are quite unevenly distributed throughout the population.

5.4 THE BEHAVIOUR

The scrutiny of the Behavioural Variables posed the most difficult problems of the investigation. It had been demonstrated in the second Pilot Survey that a format involving pre-assigned response categories was too inflexible to explore the wide variety of behaviour. Conversely, a completely unstructured response is not only difficult to quantify, but may well omit areas of particular interest to the experimenter. In an attempt to obtain the best compromise, both types of questions were included. A series of general questions were asked concerning behaviour, followed by specific questions concentrating on two aspects, evacuation of the building and movement through smoke.

The general questions were of the form shown below.



6 What was the first thing you did when you realised there was a fire?

What did you do next?

and next?

After the questionnaires were returned to the investigator each "action" was coded for each of the above questions. The category into which each action was assigned was intended to be of a general descriptive nature, thus for instance, almost all attempts to verify the nature or seriousness of the fire would fall into the general category "Investigate". Using this method of coding, the responses for each of the above questions were reduced to the 29 categories shown in Table 5.

The categories in Table 5 overleaf represent an exclusive list of the actions taken by the interviewees. It will be seen that the categories are not all of the same type, some being of a more general nature than others. It is possible to combine categories into more general classes, although of course much of the detail is lost in this process. Such combinations have been made in the analysis where it is necessary to illustrate specific points.

TABLE 5. General behaviour during incidents

Category		Percentage		
		First action	Second action	Third action
1.	Investigate fire	12.18	2.23	0.68
2.	Contact Fire Brigade	10.12	11.13	8.48
3.	Move away from fire	1.82	2.14	1.41
4.	Move towards fire	5.61	3.15	1.23
5.	Warn other people	8.07	3.60	1.14
6.	Move towards exit	1.64	1.37	0.32
7.	Leave building	7.98	8.80	8.39
8.	Some fire-fighting action	14.91	18.33	12.36
9.	Something to minimise risk	2.96	1.41	1.28
10.	Save personal effects	1.19	0.96	0.96
11.	Raise general alarm	2.74	1.14	0.18
12.	Organise evacuation	1.78	1.69	1.00
13.	Request help from others	2.23	2.37	1.46
14.	Give help to others	1.73	2.74	1.46
15.	Await rescue by Fire Brigade	0.00	0.14	0.50
16.	Something which increases risk	0.59	1.05	0.82
17.	Attempt to rescue someone	0.18	0.36	0.27
18.	Return into the building	0.05	2.23	2.05
19.	Switch off gas/electric services	4.10	2.55	1.60
20.	Contact someone in authority	2.14	2.10	1.37
21.	Shut door(s)	3.10	4.01	2.23
22.	Get family out of building	5.43	3.56	1.50
23.	Move the burning object	1.23	1.64	1.19
24.	Get dressed	2.23	0.64	0.18
25.	Assist Fire Brigade	0.05	0.50	1.23
26.	Enquire if Fire Brigade sent for	2.83	3.33	2.14
27.	Move to a safe place (within bldg)	0.78	1.46	1.32
28.	Cover face with wet towel etc	0.18	0.41	0.09
29.	Inaction (watch others etc)	2.14	14.96	43.14
	(N = 2193 in each case) Total	100.00	100.00	100.00

In this preliminary analysis there are two main ways in which the data on actions may be examined:

(a) We can look at each individual column in Table 5, representing an ordered action separately.

(b) We can consider the combinations of the first, second and third actions, each representing a course of action.

We will discuss the data only very briefly by the method in (a) above, since examining each separately is of only limited value. We will obtain a more meaningful description of behaviour when we take into consideration how the actions relate to each other.

Let us then look briefly at the individual columns. The five most popular first actions are

(a) Some fire-fighting action
(b) Investigate fire
(c) Contact Fire Brigade
(d) Warn other people
(e) Move towards fire

The high position accorded to "Some fire-fighting action" may be partially due to the more general nature of this category, which would include activities expressing the intention of fighting the fire. However such distinctions seem rather debatable, and the essential point remains that nearly 15% of those interviewed were prepared to "attack" the fire as a first action.

As an initial action we would expect many people to attempt to verify the nature of the fire, so the position of "Investigate" is unsurprising.

The ordinal position of "Contact Fire Brigade" is gratifying although the lowly percentage is much less so.

The same can be said for "Warn other people", which is of course a very socially responsible action, far removed from "Inappropriate behaviour".

"Move towards fire" is a rather difficult category since it is like "fire-fight", a very general category, but one in which the intention is not clear. Such an action may be either investigative or the precursor of active fire-fighting.

The picture changes somewhat if we combine categories. For instance combining categories 9, 19 and 21, all facets of a wish to minimise the danger, creates the third most popular action.

Combining categories 2 and 26 raises the general category concerned with contacting the Fire Brigade to the second most frequent action. A revised list with other combinations is shown below.

(a) Some fire-fighting action
(b) Contact Fire Brigade (combining 2 + 26)
(c) Investigate
(d) Warn others (combining 5 + 11)
(e) Something to minimise danger (combining 9, 19 + 21)

These five rather more general categories account for more than 60% of first actions. If we add a further two categories

(f) Evacuate oneself from building (combining 6 + 7)
(g) Evacuate others from building (combining 12 + 22)

we have described nearly 80% of the first actions in these seven classes.

A list of the five most popular second actions is shown below.

(a) Some fire-fighting action
(b) Inaction
(c) Contact Fire Brigade
(d) Leave building
(e) Shut doors

The three categories "Investigate", "Move towards fire", and "Warn other people" have dropped completely from this top five. We would have expected the former two categories to become the less frequent, but clearly warning other people, if it is not thought of to start with, is hardly thought of at all. The large numbers in "Inaction" are derived in large measures from these three initially popular categories, since other percentages in the column remain fairly stable.

In comparisons between first and second actions, it is interesting that the types of first actions taken seem to be more variable. For instance, the number of actions with more than 5% in them (that is 100 people) is 7 in column 1 and only 4 in column 2. Also the most popular four actions in column 1 account for 45%, whereas the most popular four in column 2 (although not the same four actions) account for 53%.

From this it would seem that behaviour during a fire becomes more "stereotyped", certain actions being chosen by progressively more people. This trend is continued in column 3, in which the most popular four actions shown below account for 72% of the behaviour.

(a) Inaction
(b) Some fire-fighting action
(c) Contact Fire Brigade
(d) Leave building
(e) Shut doors

Apart from the reversal of the first two categories, this list is the same as that for the second column. The most striking thing about this column is the enormous increase in the numbers of people who adopt some form of "passive" behaviour, which is classed here as "Inaction". Aside from the actions in (b), (c) and (d) immediately above, this increase in passive behaviour appears to be at the expense of all other action categories.

Let us now look at the results of how actions combine to form courses of action. Since the actions are not mutually exclusive, then for our 29 categories in each group there are 29^3, that is 24,389 possible courses of action. On this basis one might be excused for wondering if any two people from our sample of 2193 would have the same combination of all three actions. However definite patterns do emerge, although our fine division of action categories is inapplicable at this stage. Inspection of the combinations of actions reveals that there are three underlying general types of reaction to fire:

(a) Concern with evacuation of the building, either by oneself or with others.

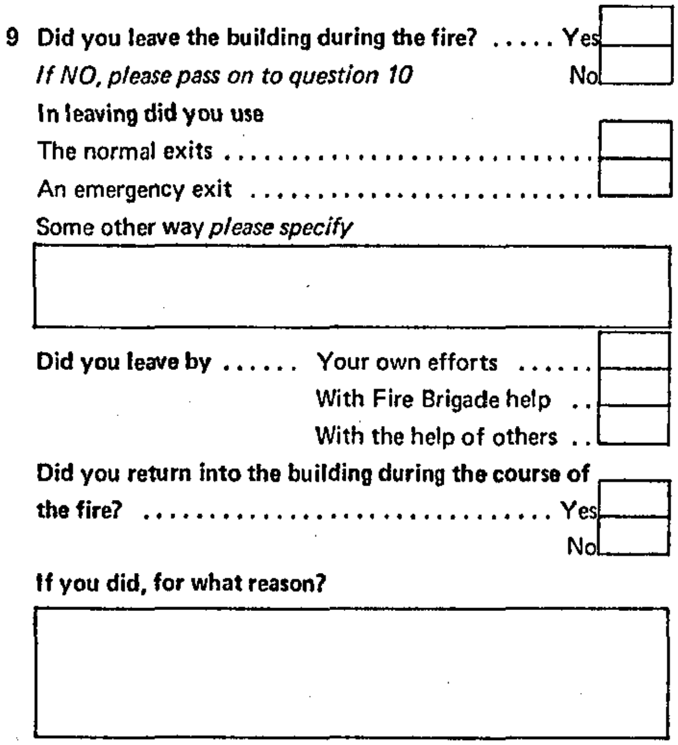
(b) Concern with fighting, or containing the fire.

(c) Concern with warning or alerting others, either individuals or the Fire Brigade.

The majority of the behaviour falls either exclusively into one of these categories, or into some combination of them. The most frequent courses of action are in fact directed solely to one end, in this case either leaving the building or fighting the fire. Approximately 5% of the interviewees were effectively inactive during the course of the incident.

In general terms, the majority of people appear to have behaved in what might be considered an appropriate fashion, although some 5% of the people did something which was judged to "increase the risk", including the apocryphal "looking for a gas leak with a lighted match". Perhaps the most common fault was opening windows "to clear the smoke". A similar percentage of people attempted to move the burning object, often a chip-pan, and therefore sustained burns or in some cases caused the fire to become more serious.

We now turn to the specific behavioural questions concerned with the evacuation of the building and movement through smoke. Those concerned with the former are shown below.



9 Did you leave the building during the fire? ..... Yes ☐
If NO, please pass on to question 10 No ☐

In leaving did you use
The normal exits .... ☐
An emergency exit .... ☐
Some other way *please specify*

Did you leave by ...... Your own efforts ...... ☐
With Fire Brigade help .. ☐
With the help of others .. ☐

Did you return into the building during the course of the fire? .... Yes ☐
No ☐

If you did, for what reason?

10 What reason did you have for not leaving? Was it because

You did not think the fire was serious enough ..... ☐

You thought you would be safer where you were ... ☐

Some other reason *please specify*

☐

The results of these questions are illustrated in the question/response chart shown in Figure 6. Some interesting points arise from this analysis:

(a) Although recognised escape routes were present in 46% of the buildings, only 3% of those who left did so using an emergency exit.

(b) Of people who did not leave the building, in 70% of the cases their reason for not doing so reflected a low-threat assessment of the fire. Nearly 50% of these people had initially rated the fire as "not at all serious", so in those cases their judgement of the threat imposed by the fire remained stable during its course.

(c) A startling 43% of those who left returned into the building.

(d) The reasons for returning into the building accurately reflect the threat-reducing effect of leaving the building, which was discussed in Section 2.0. Almost all the reasons demonstrate a "second thought" type of response. One can hypothesise that these people represent those whose immediate reaction was to leave the building. Once outside, a more "rational" attitude prevails; they perhaps recall things they should have done, or question their initial assessment of the fire, and thus return in.

Movement through smoke was explored in the questions which appear overleaf. The results of these questions are shown in Figure 7. Histograms of distances are illustrated in Figure 8. Points of interest arising from the questions are:

(a) For incidents in which smoke was present, 60% of the people interviewed were prepared to move into it. This is an extremely interesting result in view of the widespread belief that people will not enter smoke.

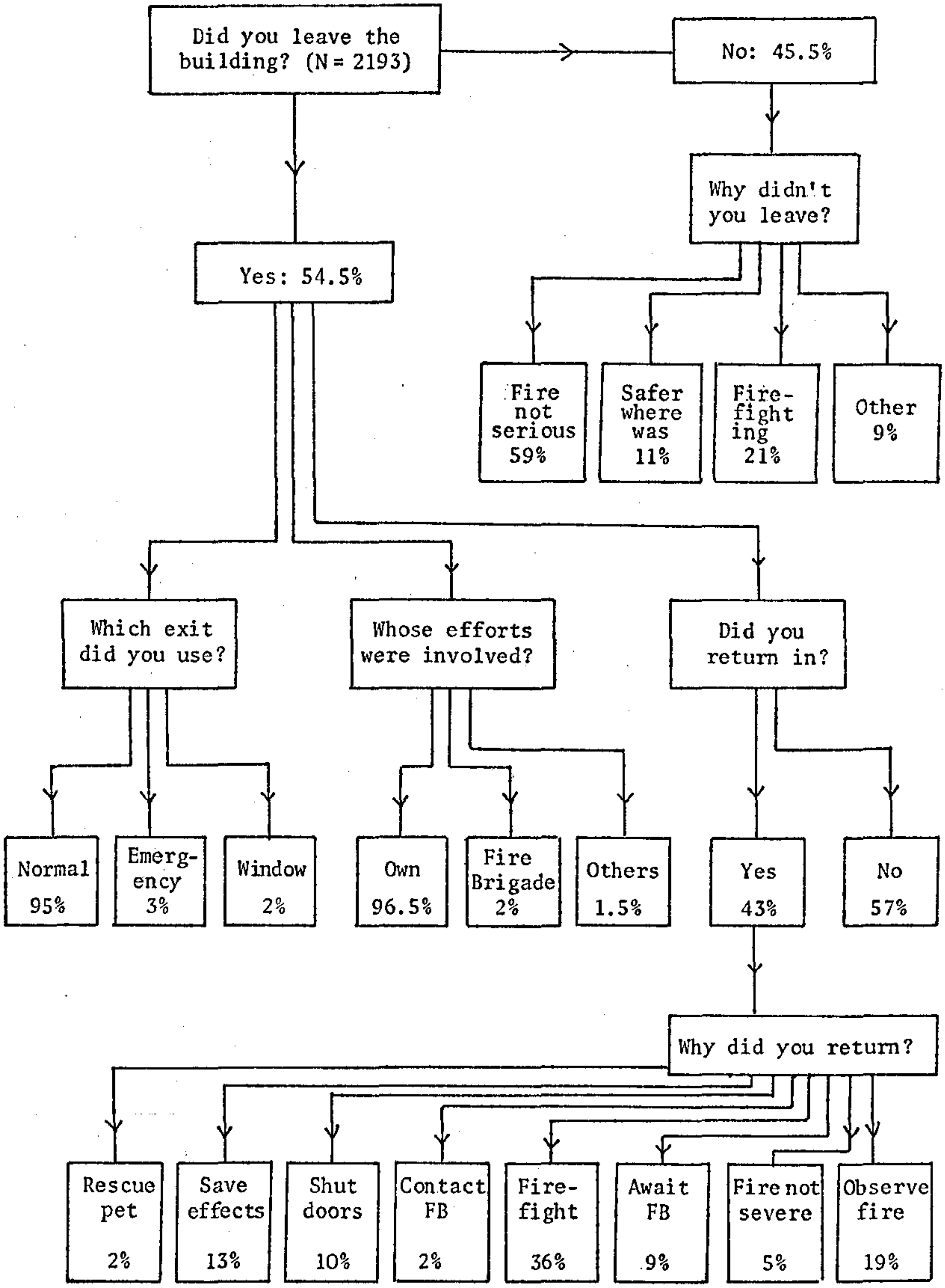
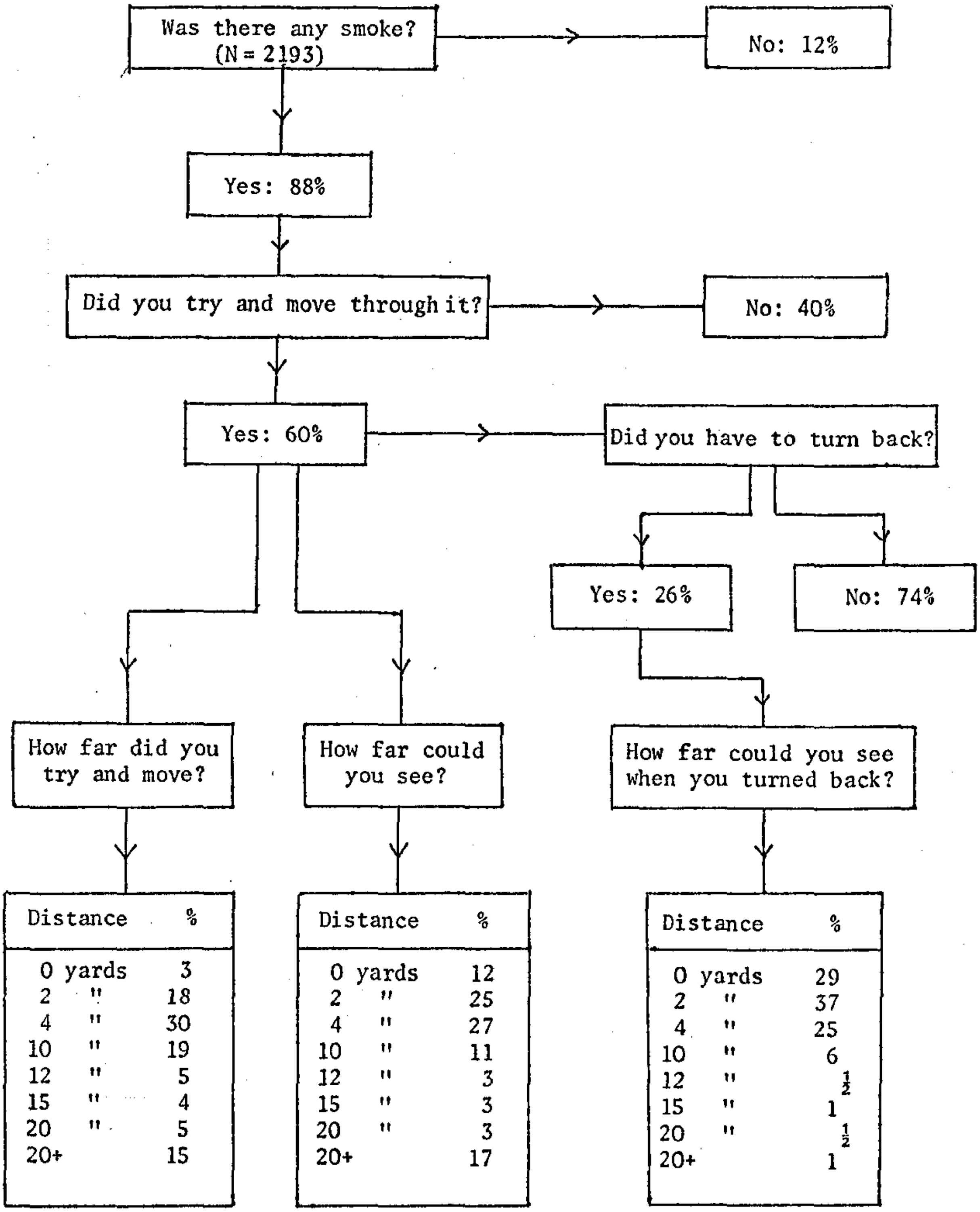


FIGURE 6. Response chart for whether or not people left the building



Distance	%
0 yards	3
2 "	18
4 "	30
10 "	19
12 "	5
15 "	4
20 "	5
20+	15

Distance	%
0 yards	12
2 "	25
4 "	27
10 "	11
12 "	3
15 "	3
20 "	3
20+	17

Distance	%
0 yards	29
2 "	37
4 "	25
10 "	6
12 "	½
15 "	1
20 "	½
20+	1

FIGURE 7. Response chart for movement through smoke

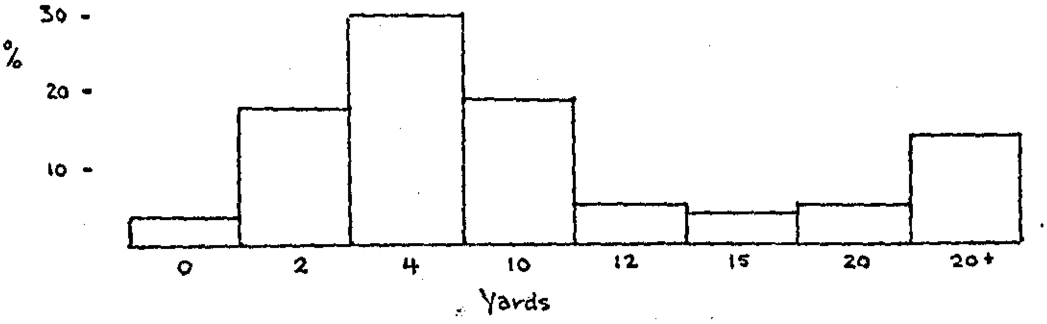


FIGURE 8(a). Percentage distribution of distances moved through smoke by interviewees

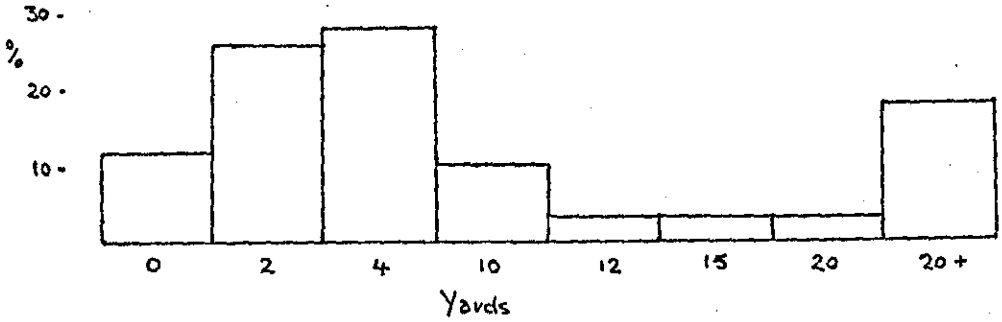


FIGURE 8(b). Percentage distribution of interviewees' visibility estimates on moving through smoke

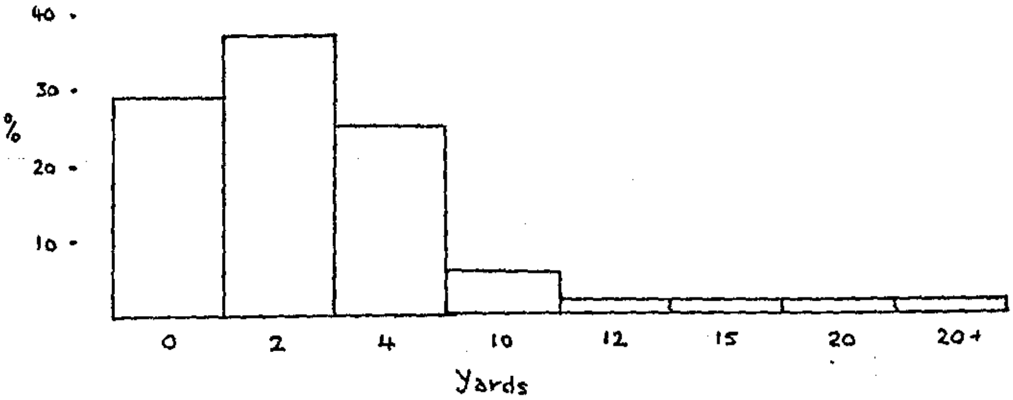


FIGURE 8(c). Percentage distribution of visibility estimates for interviewees who turned back

11 Was there any smoke? .... Yes ☐
If NO, omit the rest of this question No ☐
Did you try to move through it? .... Yes ☐
If NO, omit the rest of this question No ☐
How far did you try to move through it?
Yards .... 0 .... 2 .... 4 .... 10 .... 12 .... 15 .... 20 .... 20+
How far ahead could you see at the time?
Yards .... 0 .... 2 .... 4 .... 10 .... 12 .... 15 .... 20 .... 20+
Did the smoke become thicker? .... Yes ☐
No ☐
Did you have to turn back because of it? ...... Yes ☐
If NO, omit the next part of the question No ☐
How far ahead could you see when you turned back?
Yards .... 0 .... 2 .... 4 .... 10 .... 12 .... 15 .... 20 .... 20+

(b) The shapes of the histograms in Figures 8a and 8b are fairly similar which could indicate that people will move through smoke only as far as they can see ahead, although this relationship is explored in a later section.

(c) As would be expected, visibility estimates of people who turned back are concentrated at the "low" end of the scale (i.e. 4 yards or less).

5.5 DISCUSSION

This completes the descriptive analysis of the Full-Scale Study data. Not unnaturally, it is tempting to enquire how representative our sample of 952 fires is of such incidents. We must, however, be absolutely clear regarding the population from which the Present Study represents a sample.

As was pointed out in Section 4.0, the sampling points for the Fire Brigade officers were kept deliberately simple, namely:

(a) Fire incidents
(b) In buildings
(c) In which people were involved

that is fires which occur in buildings occupied at the start of the fire.*

Official statistics for fires are published annually (usually three years in arrears) by The Department of the Environment, under the title of " UK Fire and Loss Statistics". Within these official statistics the initial breakdown of fires is into two broad categories, "In Buildings" and "Not In Buildings". The incidents covered by the Present Study clearly represent a sub-sample of the "In Buildings" group (see Figure 1). Thus any comparison between the Present Study data, and the nearest equivalent official statistics (the "In Buildings" fires), are of dubious validity since we are not comparing like with like. Not only do we have no information on what proportion of fires occur in buildings which are empty of people at the time (not derelict buildings), but neither do we know how these incidents are distributed across the population of building types (or occupancies). Whilst it is certainly known, for example, that the majority of fires which occur in schools do so when the buildings are empty, we have no definite information regarding other occupancies. We might speculate, however, that "empty building" fires are more frequent in schools, colleges, offices, shops, warehouses, stores, and to a certain extent other industrial premises, simply because these types of building are often only occupied for a part of each 24 hours. If this were the case, it might well go some way towards explaining the preponderance of dwelling fires, relative to the number of incidents for factories, schools, etc, recorded in the Present Study. This hypothesis is also supported by the difference in distribution of Incidents by Time between the Present Study sample and the In Building sample (Tables 2 and 2a, Section 5.1). In this we see that the present sample had proportionately more morning, and fewer evening fires, which are the times that we would expect non-dwelling buildings to respectively contain and not-contain people. In other words, the In Buildings group must contain an unknown proportion of incidents in which, by the definition of the present sample, people are not involved.

Clearly a descriptive analysis of the data does no more than show how the variables are distributed. Any attempts at interpretation would be inappropriate at this stage. Subsequent chapters will examine how the variables are inter-related, and analyse particular types of incident in detail.

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* It will be readily apparent that even these superficially simple parameters are not free from ambiguity. The definitions of all three could theoretically give rise to dispute, ("... is a garden shed a building for instance?, ... is the presence of flame a prerequisite of fire?, ... what exactly do we mean by involved?"... and so on). In the event, during the data collection, these somewhat pedantic issues did not arise for the practically oriented Firemen, who appeared to have little difficulty in correctly interpreting the requirements.

5.6 THE RELATION BETWEEN THE STUDY VARIABLES: A NOTE ON THE METHODS OF ANALYSIS

The descriptive analysis conducted in the previous sections gives an outline of the broad range of the Study variables. Such a preliminary analysis is clearly necessary in defining the population of variables, however our primary interest lies in how these variables may be associated. In the subsequent chapters concerned with quantitative analysis of the data (Chapters 6 to 13), this has been undertaken in the following ways:

5.6.1 SIGNIFICANCE TESTING

The major method of analysis has been to cross-tabulate the Study variables against each other in contingency tables, and to test for association between them using a standard method of significance testing, namely the χ^2 test.

The χ^2 test is in such common usage that we will not describe its operation in detail here. Basically it tests the reality of any association by comparing the observed frequencies in the cells of the contingency table, with the frequencies which would be expected if the variables were independent. The test enables us to calculate the probability that the size of any discrepancy is as great, or greater than that which could be attributed by chance factors.

Whilst the χ^2 test is a fairly powerful tool for this purpose it does have two drawbacks in the present instance. Firstly, it does not give an indication of the strength or intensity of any relationship, merely that one can or cannot reject a null hypothesis at the predetermined level of signifcance*. Secondly, whilst χ^2 is not limited to simple pairs of variables, it is of less value when considering a number of variables simultaneously. For this reason a second method of analysis was undertaken for selected variables only (Chapter 13). It is briefly described below.

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* A common error is to confuse statistical significance with substantive significance. By this it is meant treating large values of χ^2 with correspondingly small probability levels, as an indicator of the strength of any relationship. This procedure is not valid.

5.6.2 FACTORIAL ANALYSIS

This method of analysis is essentially an analysis of variance for binary data. It is fully described in Yates (1960) and Armitage (1971), thus only a brief outline is provided here. Where a number of dichotomous variables are being analysed simultaneously they may be arranged in the form of a large contingency table.

For example, suppose in the present investigation we wish to simultaneously investigate the effect of two Incident variables, the presence of smoke, and the time of the fire (in terms of day and night) and a Personal variable, whether the individual had previously been involved in a fire, ... upon a Behavioural variable, whether or not the person had left the building. The data may be laid out in the following way:

Previously involved a^1				Not previously involved a^0			
Smoke present b^1		Smoke absent b^0		Smoke present b^1		Smoke absent b^0	
Night c^1	Day c^0	Night c^1	Day c^0	Night c^1	Day c^0	Night c^1	Day c^0
ABC	AB	AC	A	BC	B	C	1

The bottom row of cells in each case contains the proportion of people who leave.

Such an arrangement is analogous to Factorial designs in the analysis of variance. The three binary variables may be regarded as being dichotomised into positive and negative levels, signifying the presence or absence of some attribute (or treatment). They are denoted in this case by a^1(positive) and a^0(negative). Thus in cell a^1 would be the number of people who had previously been involved in a fire, whilst cell a^0 would contain the number who had not been previously involved. Similarly, cell b^1 contains those who had been previously involved, in incidents where smoke was present, and cell b^0 contains those who had previously been involved, in incidents where smoke was absent, and so on.

The eight combinations of the three variables is shown in the bottom line of the table. Cell AB, for example, contains the interaction of A and B at the positive level, that is Previous involvement and Smoke present, and C at the negative level, that is in Daytime incidents. The single letters A, B and C represent the main effects, Previous involvement, Smoke presence and Night-time incidents respectively, in each case the other variables being at the negative level.

The analysis postulates a linear model, involving transformation of the proportions onto an alternative scale, in this case the logit scale, arrangement of the data into a factorial layout as above, application of weighting coefficients (related to the value of n) to the transformed proportions and calculation of a standard error term. Estimates of main effects and linear contrasts are calculated.

The advantages of applying this type of analysis to the data of the Present Study are as follows:

(a) Where main effects are considered, they provide confirmation of the significance testing of pairs of variables.

(b) The value of the Z-scores produced is a measure of the importance of the relationships.

(c) The linear contrasts provide insight into the interaction of the Study Variables.

(d) Comparison between Z-scores for main effects and interactions is a measure of their relative strength, or importance.

It does, however, have a major drawback. Although this method of analysis may be applied to multiple classification variables, interpretation of results is much more difficult than when the variables are dichotomous. Therefore its application is usually restricted to binary variables.

It will be appreciated that in the Present Study only a proportion of the variables are naturally dichotomous. Clearly, if one were prepared to reclassify all the variables into two categories the data could be examined by factorial analysis alone, since it provides information on both main effects and interactions. This has not been undertaken for two reasons. Firstly, many of the Study variables have no obvious distinct point at which they could be divided. For these variables therefore, the recategorisation would be essentially arbitrary and any associations spurious. Secondly, a preliminary analysis of the data indicated that the Study variables were, in general, related in simple rather than complex ways. In other words, the interactions between the variables, which indicate that an association is conditional upon the level of another factor, were of much less importance than the main effects. We have therefore concentrated the main analyses on variables considered in pairs, and deferred discussion of factorial analysis to Chapter 13, where its major value will be to indicate the strength of the relationships between those selected variables for which it is considered appropriate.

In addition to these overall methods of analysis, we will, where comparisons between ranked or rated data are required, use a non-parametric correlation coefficient, Spearman's rho for examining the relationship between variables, or alternatively where appropriate, the Kruskal-Wallis one-way analysis of variance by ranks.

5.6.3 PRESENTATION OF THE DATA AND SIGNIFICANCE LEVELS

Throughout the following chapters a standard format has been adopted for presenting the majority of the cross-tabulated data.

(a) Each cell within the body of the table contains three sets of numbers.

(b) The unbracketed numbers are cell frequencies.

(c) The numbers in brackets to the right of the cell frequency represent row percentages.

(d) The numbers in brackets underneath the cell frequency represent column percentages.

This practice has only been abandoned where

(a) A large number of cells contain zero values.

(b) Where categories have been combined into a contingency table.

The χ^2 statistic is of course calculated on cell frequencies. Before deciding whether to accept a value of χ^2 as indicating an association between the variables, the researcher must determine what level of significance it must reach (that is, the probability of obtaining a value of χ^2 as large as the one calculated from the sample, by chance). The most common level used in social science research appears to be 0.05

(i.e. 5%); however it has been pointed out that decisions on significance level should be based in part on the number of cases. When a sample is very large, even small deviations will generate statistically significant χ^2 values (Nie, N H et al, 1970). For this reason, as the sample in the Present Study is relatively large, a more rigorous probability level of 0.01 (i.e.1%) was adopted throughout as the value which χ^2 must reach before the association was accepted as statistically significant. On this basis we are taking the risk that any significant association would occur by chance only 1 time in 100.

Having briefly discussed the major means by which the data will be analysed, we will now move on to consider the relationship between the variables.

CHAPTER 6

BUILDING TYPES & FIRE VARIABLES

6.0 BUILDING TYPES AND FIRE VARIABLES

In this chapter we will explore associations between the nature of the fire (and some of its effects), and the category of building in which it occurred.

Since a number of the 20 separate categories of buildings identified in Section 5.2 contain very small frequencies, and as we are from this point more interested in the "occupancy" of the building (that is whether it was a building in which people lived, or one in which they worked, etc), the 20 categories of building have been reduced to 5 for all further analyses. This has been done by combining similar types of building in the following manner.

New category	Old category
1. Dwelling	1. Dwelling house 3. Block of flats 4. Multi-occupancy
2. Industrial	2. Factory 11. Garage (not private) 12. Warehouse/Store 19. Boiler house
3. Retail	8. Shop (unspecified) 9. Public house 10. Fish and chip shop 13. Cafe/Restaurant 14. Laundrette
4. Institution	5. School 6. Hotel 7. College 15. Hostel/Home 18. Hospital
5. Office/Other	16. Office 20. Other

Only one of these reclassifications is open to real argument and that is the placing of "Hotel" in the Institution category. However this approximation is unlikely to be of significance, representing as it does only 6 incidents (0.7%) of the total sample.

There is no single agreed measure of the "severity" of a fire. The organisations concerned with fire - Fire Brigades, The Home Office, Insurance companies, etc, - may each use a variety of measures. These may relate to the physical damage to the building, the equipment used to extinguish the fire, the monetary cost of the fire in terms of replacement damage, the number of casualties, and so on. Each of these, individually or in combination, may provide some metric for distinguishing and ordering the physical effects of fire. However, in relation to the method of data collection employed in the Present Study, a number of the above have the major disadvantage that they are not capable of being assessed at the actual time of occurrence of the fire. In the present case, therefore, we are constrained by the necessity to include only those measures which can be recorded at the time of the incident, or within a short period afterwards.

The following four basic categories of Fire Variables which satisfy the above constraint were included in the Present Study:

(a) Measures which relate to the extent of Fire Spread.

(b) Measures which relate to the Fire Brigade equipment used to extinguish the fire.

(c) Measures which relate to the extent of Smoke Spread and Smoke Density.

(d) Measures which relate to the number of casualties or rescues.

We will examine the effect of the first three of these in the following sections and the fourth in Chapter 7.

6.1 FIRE SPREAD AS A MEASURE OF FIRE SEVERITY

The variables utilised to record fire spread in the Present Study were as follows:

(a) The number of rooms involved in the fire

(b) The number of levels (floors) involved in the fire

(c) The number of constructions (i.e. separate buildings) which were involved in the fire.

6.1.1 NUMBER OF ROOMS INVOLVED IN THE FIRE

The distribution of this variable across building categories is illustrated in Table 6 below.

TABLE 6. Number of rooms involved in the fire by building category

Building category	Number of rooms involved										Total
	1	2	3	4	5	6	7	8	9	10	
Dwelling	548	30	11	5	-	1	-	2	-	1	598
Industrial	177	12	3	1	1	-	-	1	-	1	196
Retail	87	8	1	1	-	-	-	-	-	-	97
Institution	36	1	-	1	-	-	1	-	-	-	39
Office/Other	24	1	-	-	-	-	-	-	-	-	2
Total	869	52	15	8	1	1	1	3	0	2	952

It will be noted that for each category of building, by far the greatest proportion of incidents only involved one room.

Since so many cells have low or zero values, we cannot test directly on Table 6 for an association between Fire Spread (as measured by the number of rooms involved), and building category. However we may overcome this difficulty by combining categories, which is a valid procedure when cell values are low or zero (see Maxwell, 1961). The most obvious division is between incidents in which one room only was involved, and incidents in which more than one room was involved. This has been done in Table 7 overleaf (which is presented in the opposite orientation for space-saving reasons). It can be seen that applying the χ^2 test to the frequencies given yields a non-significant result of 1.39 (4 df). We can thus state with some certainty that the extent of Fire Spread (as measured by the number of rooms involved) does not differ between building categories.

6.1.2 NUMBER OF LEVELS (FLOORS) INVOLVED IN THE FIRE

The distribution of this variable across building categories is illustrated in Table 8 (p.77). Inspection of this table again reveals that the data are very positively skewed, and using the same rationale as in Section 6.1.1, we shall abandon our multiple classification of

TABLE 7. Building category by number of rooms involved in the fire

Number of rooms involved	Building category					Total
	Dwelling	Industrial	Retail	Institution	Office/Other	
1 room involved	546 (62.8) (91.3)	177 (20.3) (90.3)	87 (10.0) (89.7)	36 (4.1) (92.3)	21 (2.4) (95.4)	869 (91.3)
More than 1 room	52 (62.7) (8.7)	19 (22.9) (9.7)	10 (12.0) (10.3)	3 (3.6) (7.7)	1 (1.2) (5.6)	83 (8.7)
Total	598 (62.8)	196 (20.6)	97 (10.2)	39 (4.1)	22 (2.3)	952 (100.0)

TABLE 9. Building category by number of levels involved in the fire

Number of levels involved	Building category					Total
	Dwelling	Industrial	Retail	Institution	Office/Other	
1 level involved	571 (63.4) (95.5)	179 (19.9) (91.3)	93 (10.3) (95.9)	37 (4.1) (94.9)	21 (2.3) (95.4)	901 (94.6)
More than 1 level	27 (52.9) (4.5)	17 (33.3) (8.7)	4 (7.8) (4.1)	2 (3.9) (5.1)	1 (2.0) (5.6)	51 (5.4)
Total	598 (62.8)	196 (20.6)	97 (10.2)	39 (4.1)	22 (2.3)	952 (100.0)

TABLE 8 . Number of levels involved in the fire by building category

Building category	Number of levels involved					Total
	1	2	3	4	5	
Dwelling	571	24	3	-	-	598
Industrial	179	13	1	1	2	196
Retail	93	4	-	-	-	97
Institution	37	2	-	-	-	39
Office/Other	21	1	-	-	-	22
Total	901	44	4	1	2	952

levels, and simply use two categories, fires which involve only 1 level, and fires which involve more than 1 level. This is shown in Table 9 on the previous page. Applying the χ^2 test to the frequencies in this table again gives a non-significant value of 5.53 (4 df). Thus Fire Spread as measured by the number of levels involved does not differ between building categories.

6.1.3 NUMBER OF CONSTRUCTIONS INVOLVED IN THE FIRE

As in Sections 6.1.1 and 6.1.2, the overall tabulation of building category by the number of constructions contains a considerable number of low cell values. This table has therefore been omitted, and we have combined categories in the manner previously described in Table 10 overleaf. Inspection of this table reveals that even our combined categories contain a number of low value cells. Any significance testing under these conditions would yield an unreliable result, and will not be undertaken. The buildings in the Industrial category appear to have a disproportionate number of incidents involving more than one construction. If we again combine categories, so as to compare Industrial and Non-Industrial incidents, we have the following 2 × 2 contingency table to which we may apply a χ^2 test.

	Non-Industrial	Industrial	Total
1 construction	751	187	938
More than 1	6	8	14
Total	757	195	952

χ^2 = 11.72 (1 df), significant at 0.001

TABLE 10. Building category by number of constructions involved in the fire

Number of constructions	Building category					Total
	Dwelling	Industrial	Retail	Institution	Office/Other	
1 construction involved	594 (63.3) (99.3)	188 (20.0) (95.9)	96 (10.2) (96.3)	39 (4.2) (100.0)	21 (2.2) (95.4)	938 (98.5)
More than 1 construction	4 (28.6) (0.7)	8 (57.1) (4.1)	1 (7.1) (3.7)	0 (0.0) (0.0)	1 (7.1) (4.6)	14 (1.5)
Total	598 (62.8)	196 (20.6)	97 (10.2)	39 (4.1)	22 (2.3)	952 (100.0)

TABLE 12. Building category by the use or non-use of Jets

Use of Jets	Building category					Total
	Dwelling	Industrial	Retail	Institution	Office/Other	
No Jets used	452 (66.2) (75.6)	121 (17.7) (61.7)	70 (10.2) (72.2)	29 (4.2) (74.4)	9 (1.3) (40.9)	683 (71.7)
Jets used	146 (54.3) (24.4)	75 (27.9) (38.3)	27 (10.0) (27.8)	10 (3.7) (25.6)	13 (4.8) (59.1)	269 (28.3)
Total	598 (62.8)	196 (20.6)	97 (10.2)	39 (4.1)	22 (2.3)	952 (100.0)

Thus Fire Spread, as measured by the number of constructions involved, is not independent of building category in the case of Industrial and Non-Industrial occupancies. Fire Spread is more extensive in Industrial rather than Non-Industrial buildings.

Notwithstanding the significant value yielded in the above case (which may be open to dispute in terms of the combining of the categories), we must conclude that, in general, Fire Spread does not differ between building categories.

We must also suggest from these analyses that Fire Spread is not a useful measure of Fire Severity on its own. The distribution of the variables is, in each case, so skewed that we cannot readily distinguish between degrees of Fire Severity, except in a very gross way.

6.2 FIRE BRIGADE EQUIPMENT AS A MEASURE OF FIRE SEVERITY

The variables in this section were included on the basis of advice from Fire Brigades. There are several such measures which could have been utilised; however the present ones were thought to be most realistic. These were

(a) The number of Jets used to extinguish the fire
(b) The number of Hose-reels used to extinguish the fire.

6.2.1 NUMBER OF JETS

The distribution of this variable across building categories is illustrated in Table 11 below.

TABLE 11. Number of Jets used to extinguish the fire by building category

Building category	Number of Jets										Total
	0	1	2	3	4	5	6	7	8	9	
Dwelling	453	121	20	4	-	-	-	-	-	-	598
Industrial	121	51	15	4	-	3	-	-	1	1	195
Retail	70	23	3	-	-	-	-	-	1	-	97
Institution	29	8	-	1	-	1	-	-	-	-	39
Office/Other	10	8	2	1	1	-	-	-	-	-	22
Total	683	211	40	10	1	4	0	0	2	1	952

Whilst we again have many low value cells, it will be noted from Table 11 (p.79) that all building categories, other than Dwellings, have one or more severe fires as measured by the number of Jets used. This is particularly so in the case of Industrial occupancies.

We may test for the reality of any relationship by combining our categories as previously, to overcome the problem of low cell frequencies. In this case we are distinguishing between incidents in which Jets are utilised and those in which they are not. The frequencies are illustrated in Table 12 (p.78).

The significant value of χ^2 (24.82, 4 df) indicates that whether or not Jets were utilised is dependent upon building category. If we partition the contingency table to examine the source of this association, it is found that both the Industrial and Office/Other categories have a disproportionately high number of incidents in which Jets are used, whereas Dwellings have a disproportionately low number.

If, therefore, we utilise the presence or absence of Jets as a measure of Fire Severity, we can state that in the Present Study, Industrial and Office/Other categories of building were more likely to be of High severity, whereas those in Dwellings were more likely to be of Low severity.

6.2.2 NUMBER OF HOSE-REELS

Again, tabulating the distribution of this variable across building categories yields a number of empty and low value cells. The multiple-classification table has thus been omitted, and we will merely classify incidents by whether or not Hose-reels were used. This is illustrated in Table 13 overleaf. Testing the frequencies yields a non-significant χ^2 value of 3.86 (4 df). We can thus state that whether or no Hose-reels were utilised to extinguish the fire was independent of the category of the building involved.

The use of Fire Brigade equipment as a measure of Fire Severity is clearly dependent upon which variable we choose. The use or non-use of Jets proved capable of distinguishing between categories of building, in terms of Low or High severity incidents, whereas the use or non-use of Hose-reels did not.

TABLE 13. Building category by the use or non-use of Hose-reels

Use of Hose-reels	Building category					Total
	Dwelling	Industrial	Retail	Institution	Office/Other	
No Hose-reels used	530 (62.2) (88.6)	179 (21.0) (91.3)	85 (10.0) (87.6)	37 (4.3) (94.9)	22 (2.6) (100.0)	852 (89.5)
Hose-reels used	68 (68.0) (11.4)	17 (17.0) (8.7)	12 (12.0) (12.4)	2 (2.0) (5.1)	0 (0.0) (0.0)	100 (10.5)
Total	598 (62.8)	196 (20.6)	97 (10.2)	39 (4.1)	22 (2.3)	952 (100.0)

6.3 SMOKE CHARACTERISTICS AS A MEASURE OF FIRE SEVERITY

The smoke produced in fire incidents is not simple in nature. It can vary in several ways, including colour, toxicity, distribution, particle size, density, and extent of spread. Clearly some of these attributes can only be measured under laboratory conditions. For the purposes of the Present Study, the variables which were selected to be of the most relevance were:

(a) The density of the smoke
(b) The extent of Smoke Spread in the building.

Both of these measures were judged by experienced Fire Brigade personnel at the time of the fire. A seven-point scale was utilised for judgements of Smoke Density and a five-category division for the extent of Smoke Spread.

6.3.1 EXTENT OF SMOKE SPREAD

The five categories utilised for this measure were as follows:

(a) Little or no Smoke Spread
(b) Smoke confined to the room of origin
(c) Smoke confined to the floor of origin
(d) Smoke Spread to the floor above
(e) Smoke Spread even more extensively.

The distribution of Smoke Spread across building categories is shown in Table 14 overleaf and illustrated in Figure 9 *. The histograms illustrate the percentage of incidents in each particular building category which have Smoke Spread in that category, i.e. column percentages, not overall percentages. Examination of Figure 9 shows that whilst the modal category for each of the three building types is the same, at "confined to the room of origin", there appear to be differences in the distribution of Smoke Spread categories between buildings. Thus Factory incidents have a substantially greater proportion of Low Smoke Spread

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* The histograms for building categories "Institution" and "Office/Other" are not included in Figure 9. It should be noted that they are derived from total samples of 39 and 22 respectively. Percentage calculations based upon such small numbers are subject to large standard errors, and we cannot be confident regarding the distribution of these two groups.

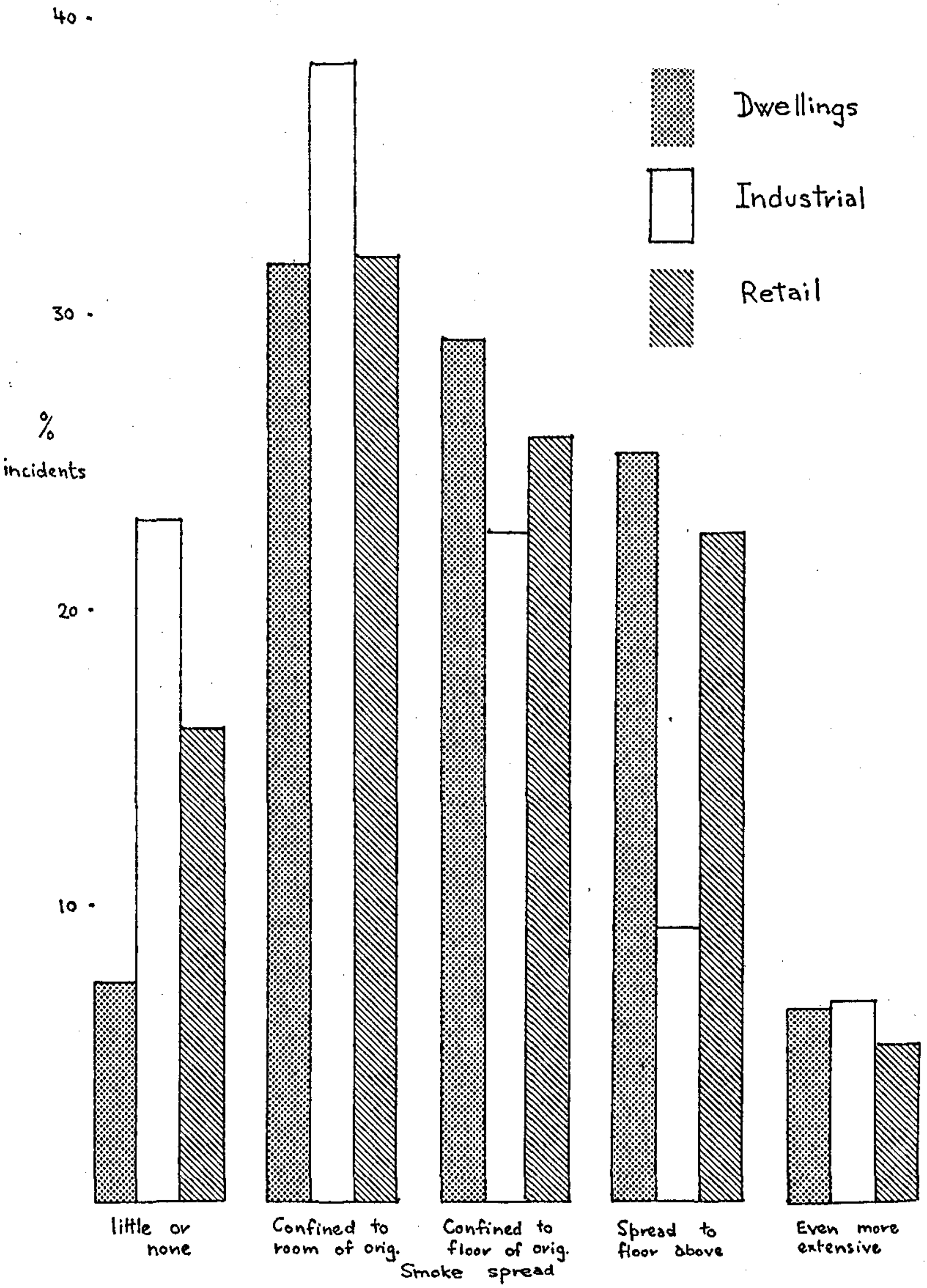

FIGURE 9. Extent of Smoke Spread by building category

TABLE 14. Extent of Smoke Spread by building category

Extent of Smoke Spread	Building category					Total
	Dwelling	Industrial	Retail	Institution	Office/Other	
Little or none	44 (40.0) (7.4)	46 (41.8) (23.5)	14 (12.7) (14.4)	5 (4.5) (12.8)	3 (2.7) (13.6)	110 (11.6)
Confined to room of origin	189 (58.9) (31.6)	75 (23.4) (38.3)	31 (9.7) (32.0)	15 (4.7) (38.5)	11 (5.4) (50.0)	321 (33.7)
Confined to floor of origin	176 (68.2) (29.4)	44 (17.1) (22.4)	24 (9.3) (24.7)	9 (3.5) (23.1)	5 (1.9) (22.7)	258 (27.1)
Spread to floor above	150 (74.6) (25.1)	18 (9.0) (9.2)	22 (10.9) (22.7)	8 (4.0) (20.5)	3 (1.5) (13.6)	201 (21.1)
Even more extensive	39 (67.2) (6.5)	13 (22.4) (6.6)	5 (8.6) (5.2)	1 (1.7) (2.6)	0 (0.0) (0.0)	58 (6.1)
Total	598 (62.8)	196 (20.6)	97 (10.2)	39 (4.1)	22 (2.3)	952 (100.0)

TABLE 15. Building category by Smoke Spread, up to floor of origin, and beyond floor of origin

Extent of Smoke Spread	Building category					Total
	Dwelling	Industrial	Retail	Institution	Office/Other	
Up to floor of origin	409 (59.0) (68.4)	165 (23.8) (84.2)	70 (10.1) (72.2)	30 (4.3) (76.9)	19 (2.7) (86.4)	693 (72.8)
Beyond floor of origin	89 (73.0) (31.6)	31 (12.0) (15.8)	27 (10.4) (27.8)	9 (3.5) (23.1)	3 (1.2) (13.6)	259 (27.2)
Total	598 (62.8)	196 (20.6)	97 (10.2)	39 (4.1)	22 (2.3)	952 (100.0)

incidents and a smaller proportion of High Smoke Spread incidents, and are therefore more positively skewed than either the Dwelling or Retail category buildings, with the former having a rather smaller proportion of Low Smoke Spread incidents and a rather greater proportion of High Smoke Spread fires.

Advice from Fire Service personnel, and indeed commonsense, suggests that in terms of threat to life, the order of severity of an incident changes radically at the point where smoke spreads beyond the floor of origin and to the floor above. With this point in mind, the Smoke Spread variable was dichotomised into the following two categories for the purpose of significance testing:

(a) Incidents where smoke was confined to the floor of origin
(b) Incidents where smoke spread beyond the floor of origin.

The frequencies in each of these categories for the different building categories are illustrated in Table 15 (p.84).

Partitioning the contingency table confirms the evidence of Figure 9, in that the Industrial category has a significantly smaller proportion of incidents with Smoke Spread beyond the floor of origin, while the Dwelling and Retail categories have a significantly greater proportion.

Using Smoke Spread as a measure of Fire Severity, we can thus state that buildings in the Dwelling and Retail categories were more likely to be of High severity, whereas buildings in the Industrial category were more likely to be of Low severity.

In addition, reference to Table 15 indicates that the extent of Smoke Spread in the incident is the first of the possible measures of Fire Severity, in which the distribution of values is such that we could identify diffferences in Fire Severity within a particular category of building.

6.3.2 DENSITY OF THE SMOKE

The density of the smoke, at its worst, was raterd on a 7-point scale (1 = lowest/7 = highest), by an experiences Fire Brigade Officer at the time of the fire. The distribution of these values is shown in Table 16 overleaf, and illustrated in Figure 10. (The histograms for the Institution and Office/Other categories have been omitted on the same basis as in Figure 9.)

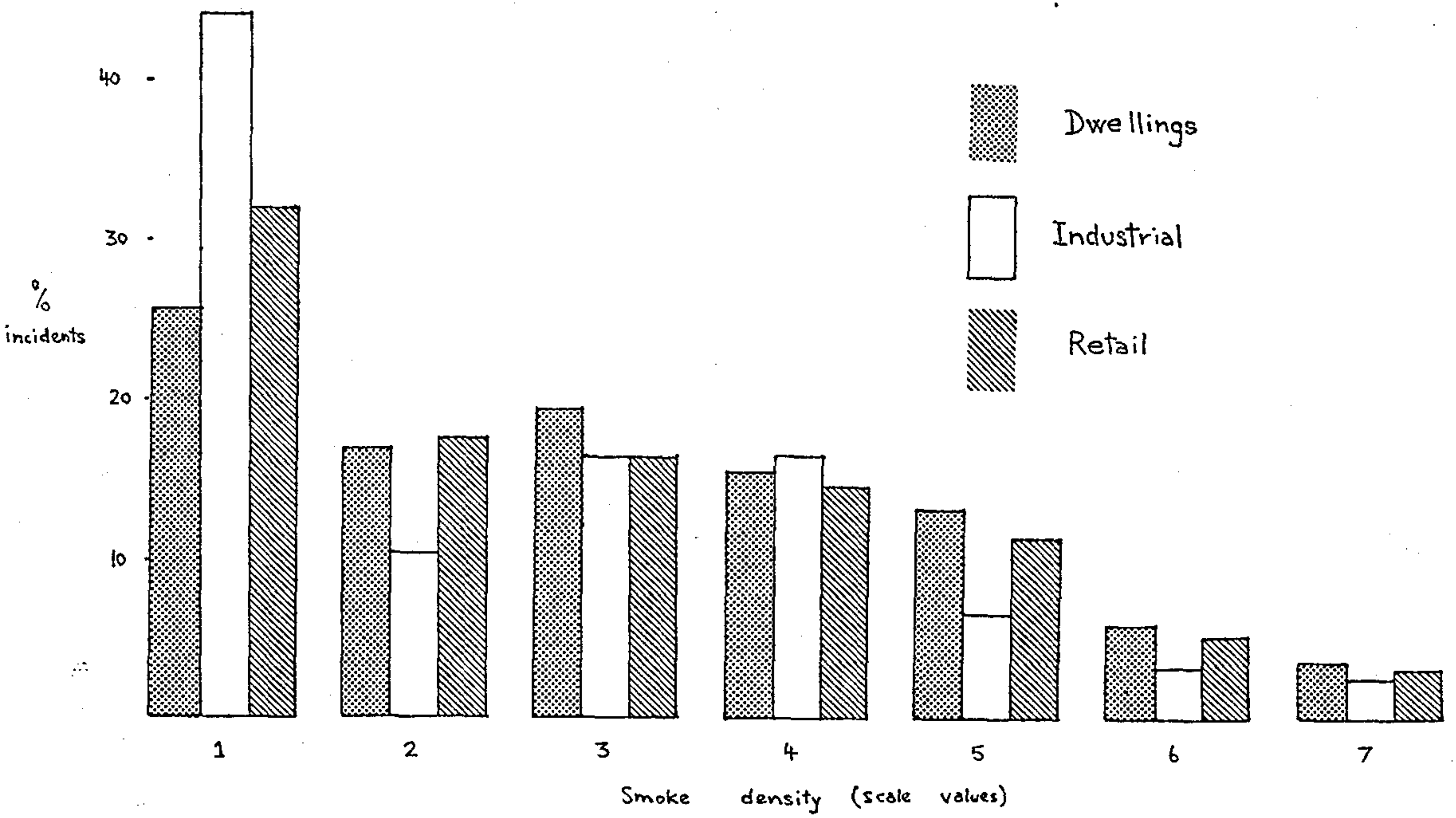

FIGURE 10. Smoke Density by building category

TABLE 16. Scale-values of Smoke Density by building category

Building category	Smoke Density scale-values							Total
	1	2	3	4	5	6	7	
Dwelling	153 (25.6) (51.3)	101 (16.9) (66.4)	116 (19.4) (68.2)	92 (15.4) (63.9)	79 (13.2) (73.1)	35 (5.9) (71.4)	22 (3.7) (71.0)	598 (62.8)
Industrial	87 (44.4) (29.2)	20 (10.2) (13.2)	32 (16.3) (18.8)	32 (16.3) (22.2)	14 (7.1) (13.0)	6 (3.1) (12.2)	5 (2.6) (16.1)	196 (20.6)
Retail	31 (31.9) (10.4)	17 (17.5) (11.2)	16 (16.5) (9.4)	14 (14.4) (9.7)	11 (11.3) (10.2)	5 (5.2) (10.2)	3 (3.1) (9.7)	97 (10.2)
Institution	18 (46.1) (6.0)	8 (20.5) (5.3)	5 (12.8) (2.9)	4 (10.3) (2.8)	2 (5.1) (1.9)	2 (5.1) (4.1)	0 (0.0) (0.0)	39 (4.1)
Office/Other	9 (40.9) (3.0)	6 (27.3) (3.9)	1 (4.5) (0.6)	2 (9.1) (1.4)	2 (9.1) (1.9)	1 (4.5) (2.0)	1 (4.5) (3.2)	22 (2.3)
Total	298 (31.3)	152 (16.0)	170 (17.9)	144 (15.1)	108 (11.3)	49 (5.1)	31 (3.3)	952 (100.0)

It will be noted from Figure 10 that, once again, incidents in the Industrial building category have a greater proportion of the lowest value of Smoke Density, and rather smaller proportions of the highest values. However, these differences are not as great as in the case of Smoke Spread, and furthermore, the Smoke Density values in the middle portions of the scale are very similar for all three classes of building.

Although Smoke Density is only an ordinal scale, we can compute mean values to obtain some idea regarding the rank order of the buildings in terms of density of smoke. It should be noted that mean values are only statistically valid when computed on interval level (or better) data. The mean values of Smoke Density are shown in Table 17 below.

TABLE 17. Building category by mean values of Smoke Density

Smoke Density	Building category					Whole sample
	Dwelling	Industrial	Retail	Institution	Office/ Other	
N =	598	196	97	39	22	952
mean value	3.06	2.51	2.84	2.29	2.50	2.88

It can be seen from Table 17 above that the order of density of smoke indicated by the mean values tends to show the Dwelling and Retail categories with high values, and the Industrial, Institution and Office/ Other ones with rather lower ones. Whilst computing mean values may be a dubious practice, a completely acceptable alternative is to utilise a non-parametric test for data of this kind, namely the Kruskal-Wallis one-way analysis of variance by ranks (Siegel, 1956). The results of this test are shown in Table 18 below.

TABLE 18. Rank order and mean rank value of Smoke Density by building category

	Building category				
	Dwelling	Industrial	Retail	Institution	Office/Other
mean rank value	509.1	406.7	464.6	388.8	418.6
rank order	1	4	2	5	3

The significance of the relationship can be tested by χ^2, which yields a value of 26.92 (corrected for ties), significant beyond the 0.0001 level.

We must conclude therefore that the Smoke Density in the incidents varied significantly between different categories of building. The rank order of the building categories in terms of density of smoke, ranging from worst to least is as follows: Dwelling, Retail, Office/Other, Industrial, Institution.

6.4 INTERMEDIATE SUMMARY

Examination of Sections 6.1 to 6.3 suggests that devising a satisfactory measure of Fire Severity is not completely straightforward. In essence, we require such a measure to exhibit three characteristics:

(a) It must occur in each incident
(b) Its distribution must vary between incidents
(c) The distribution must be over a wide range.

If these conditions are satisfied, then our measure will be capable of distinguishing Fire Severity, both within building categories and between building categories.

The findings of Sections 6.1 to 6.3 have been summarised in tabular form, and they appear in Table 19 overleaf. It can be seen from this table that, not only are several of our chosen measures ineffective in discriminating between incidents or building categories, but also, those measures which are effective produce contradictory findings. This is not entirely unexpected, in that each measure is assessing a different aspect of the nature of the fire. It may well be that there is a real difference between, for example, Industrial fires and Dwelling fires. The evidence of Table 19 would suggest that the former are characterised by severe flames and heat, thus requiring more Jets to extinguish them, whilst the latter are more likely (perhaps because of the combustion of soft furnishings) to have dense and extensive smoke.

Notwithstanding the above comment, the fact remains that of all the measures, only the measures of smoke characteristics are sufficiently sensitive to distinguish between individual incidents. However, were we to adopt smoke characteristics as our sole measure of Fire Severity, this would clearly be inefficient, since we are not utilising all the information contained in the other observations. It was thus felt necessary to derive a single measure of Fire Severity which included all the data.

TABLE 19. Summary of discriminating power of Fire Severity measures

Fire Severity measure		Discrimination within building categories?	Distinction between building categories?	
			Low severity	High severity
Extent of Fire Spread	Number of rooms	No	No	No
	Number of levels	No	No	No
	Number of constructions	No	-	Industrial
Use of Fire Brigade equipment	Number of Jets	No	Dwelling	Industrial
	Number of Hose-reels	No	No	No
Smoke Characteristics	Smoke Spread	Yes	Industrial	Dwelling Retail
	Smoke Density	Yes	Industrial Institution	Dwelling Retail

6.5 A COMBINED INDEX OF FIRE SEVERITY

It was considered that a simple additive index, i.e. simply adding together the number of rooms, levels, constructions, Hose-reels, Jets, Smoke Density and Smoke Spread values, would not be sufficiently sensitive to distinguish between severe and non-severe fires. We can illustrate this with an example. Suppose we were comparing two Dwelling fires:

Dwelling Fire A	Number of rooms involved	= 1
	Number of levels involved	= 1
	Number of constructions involved	= 1
	Number of Jets	= 0
	Number of Hose-reels	= 0
	Smoke Spread (little or none)	= 1
	Smoke Density (scale value)	= 2
	Total Index value	= 6
Dwelling Fire B	Number of rooms involved	= 1
	Number of levels involved	= 1
	Number of constructions involved	= 1
	Number of Jets	= 1
	Number of Hose-reels	= 0
	Smoke Spread (little or none)	= 1
	Smoke Density (scale values)	= 1
	Total Index value	= 6

Superficially both incidents have the same severity; however it can be seen that a small difference in Smoke Density between the incidents masks the fact that one incident requires a Jet, whereas the other does not, which is a big difference especially for dwelling fires. In an attempt to overcome this difficulty, it was decided to give additional weight to those factors which are thought to mark the threshold between incidents of different character. This was done in the following way for the variables included in our assessment.

(a) The number of Jets used at an incident was multiplied by 3.

(b) The number of Hose-reels used at an incident was multiplied by 2.

(c) The Smoke Spread had the following values attached to it:
"Little or no Smoke Spread" = 1
"Confined to the room of origin" = 2
"Confined to the floor of origin" = 3
"Spread to the floor above" = 6
"Even more extensive" = 8

All other observations remained unchanged in value. It can thus be seen that we have given considerable extra weight in our calculation to any incident in which Fire Brigade equipment was used, and also any incident where the smoke spread further than the floor of origin. It is clear that this weighting process is essentially arbitrary, and its validity can be questioned; however the modifications were derived after much trial and error and the final metric appears to satisfy the criteria described in Section 6.4, whilst including all our recorded information on Fire Severity.

To reiterate, our derived measure of severity, the Fire Severity Index (henceforth abbreviated to FSI) was calculated in the following manner:

$$\begin{aligned}\text{FSI} = {} & (\text{number of rooms}) + (\text{number of levels}) + (\text{number of constructions}) \\ & + (3 \times \text{number of Jets}) + (2 \times \text{number of Hose-reels}) \\ & + (\text{Smoke Density scale value from 1 to 7}) \\ & + (\text{Smoke Spread value from 1 to 8}).\end{aligned}$$

The percentage distribution of FSI values is shown in Figure 11. The minimum value calculated was 4 and the maximum value was 48. It would thus appear that the range is sufficiently large to detect differences between incidents. It will be noted from Figure 11 that the distribution is very positively skewed, with the majority of incidents having FSI values in the range 6 to 16. It is encouraging that only one value contains more than 10% of incidents, suggesting that the FSI value is a sensitive measure, being (relatively) uniformly distributed compared with some of our earlier measures.

We will now examine how FSI values are distributed between different categories of building.

6.5.1 FSI VALUES IN RELATION TO BUILDING CATEGORY

Whilst the wide range of FSI values illustrated in Figure 11 is clearly of value when comparing individual incidents, it would be extremely cumbersome to cross-tabulate these with the five categories of building. It is nonetheless of importance to examine whether there are differences in the FSI between our building categories. This difficulty has been handled in two ways.

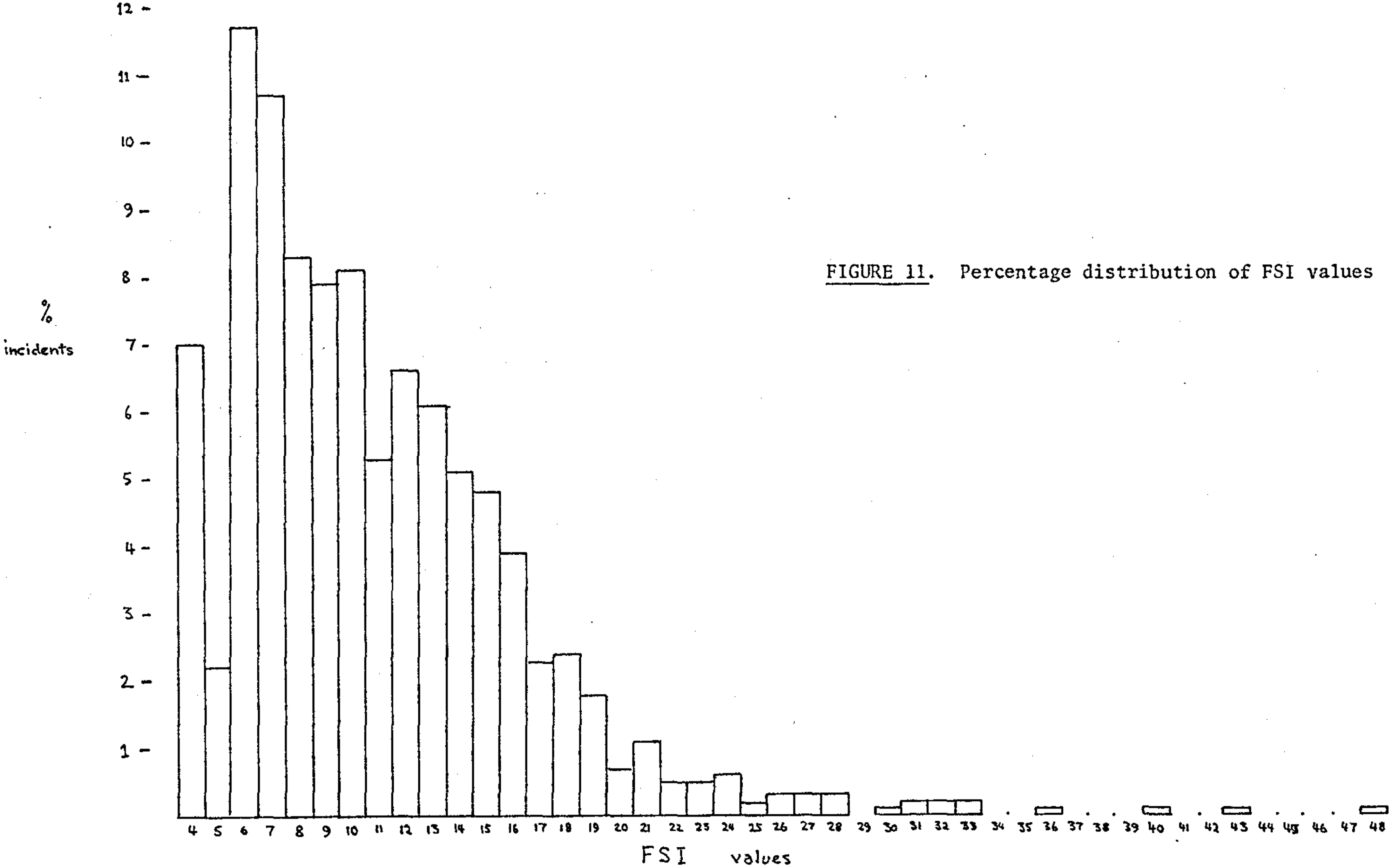

FIGURE 11. Percentage distribution of FSI values

(i) Categorisation of FSI values

To achieve a more workable range of FSI values, the 44 categories illustrated in Figure 11 were divided into 5 "levels" of FSI value, and these were as follows:

Level 1. "Very Low severity" incidents, with an FSI value of less than 7.

Level 2. "Low severity" incidents, with FSI values between 7 and 10 inclusive.

Level 3. "Medium severity" incidents, with FSI values between 11 and 14 inclusive.

Level 4. "High severity" incidents, with FSI values between 15 and and 17 inclusive.

Level 5. "Very High severity" incidents, with an FSI value greater than 17.

Reference to Figure 11 shows that this reclassification of FSI values divides the distribution up fairly evenly other than for the "Very High severity" incidents which, since they are comparatively rare, contains proportionately lower numbers. Table 20 overleaf shows this reclassified FSI level in relation to building category.

Examination of the column percentages in Table 20 suggests that there is very little consistent difference between the categories of building, in terms of the level of FSI. This suspicion is borne out if we apply the χ^2 test, which yields a non-significant value of 16.6 (16 df). We may thus state that there is not difference in Fire Severity between categories of building, as measured by our categorised Fire Severity Index.

(ii) Mean values of FSI

Since the Fire Severity Index is derived from the arithmetical manipulation of a series of ordinal scales, it cannot itself achieve higher than an ordinal level of measurement. Strictly speaking therefore, calculation of mean values is an invalid procedure. It has been suggested however that such a calculation is acceptable if the resulting values are only used for illustrating differences in order between variables, and not the magnitude of these differences (see Stevens, 1951).

TABLE 20. Building category by level of FSI

FSI level	Building category					Total
	Dwelling	Industrial	Retail	Institution	Office/Other	
Very Low	113 (56.2) (18.9)	53 (26.4) (27.0)	22 (10.9) (22.7)	11 (5.5) (28.2)	(1.0) (9.1)	201 (21.1)
Low	205 (61.6) (34.3)	70 (21.0) (35.7)	32 (9.6) (33.0)	16 (4.8) (41.0)	10 (3.0) (45.5)	333 (35.0)
Medium	154 (70.0) (25.8)	36 (16.4) (18.4)	18 (8.2) (18.6)	6 (2.7) (15.4)	6 (2.7) (27.3)	220 (23.1)
High	67 (63.8) (11.2)	19 (18.1) (9.7)	14 (13.3) (14.4)	3 (2.9) (7.7)	2 (1.9) (9.1)	105 (11.0)
Very High	59 (63.4) (9.9)	18 (19.4) (9.2)	11 (11.8) (11.3)	3 (3.2) (7.7)	2 (2.2) (9.1)	93 (9.8)
Total	598 (62.8)	196 (20.6)	97 (10.2)	39 (4.1)	22 (2.3)	952 (100.0)

On this basis, therefore, we have calculated mean values of FSI for the five building categories which are shown in Table 21 below.

TABLE 21. Mean value of FSI by building category

	Building category					Whole sample
	Dwelling	Industrial	Retail	Institution	Office/ Other	
N =	598	196	97	39	22	952
mean FSI	10.98	10.64	10.68	9.92	10.91	10.83

Examination of Table 21 shows that apart from the Institution category, which has a slightly lower mean FSI value, other differences between building categories are only marginal, and none differ very greatly from the overall population mean FSI.

Therefore on this basis also we can state that there is no variation in the severity of fires between building categories based upon our combined Fire Severity Index.

The possible conclusions we may draw from this finding are that, firstly, our computed index is insensitive to differences in Fire Severity, or secondly, there is in fact no difference between the buildings in Fire Severity. Since we have earlier seen that on some individual measures there is variation between building categories, it seems that the former hypothesis is more likely.

It will be recalled that in deriving the combined FSI, extra weight was given to both Smoke Spread and Fire Brigade equipment. The failure of FSI to distinguish between categories of building probably arises out of the fact that the added weight to building categories with high Smoke Spread (Dwelling and Retail), is balanced in this case by the added weight to the building category with a greater proportion of fires involving Jets (Industrial).

6.6 FIRE SEVERITY MEASURES AND TIME OF THE INCIDENT

If we examine the frequency distribution of fires against time for the Present Sample (Figure 12), it can be seen that there are definite peaks in relation to the time of occurrence of the fire. These peaks

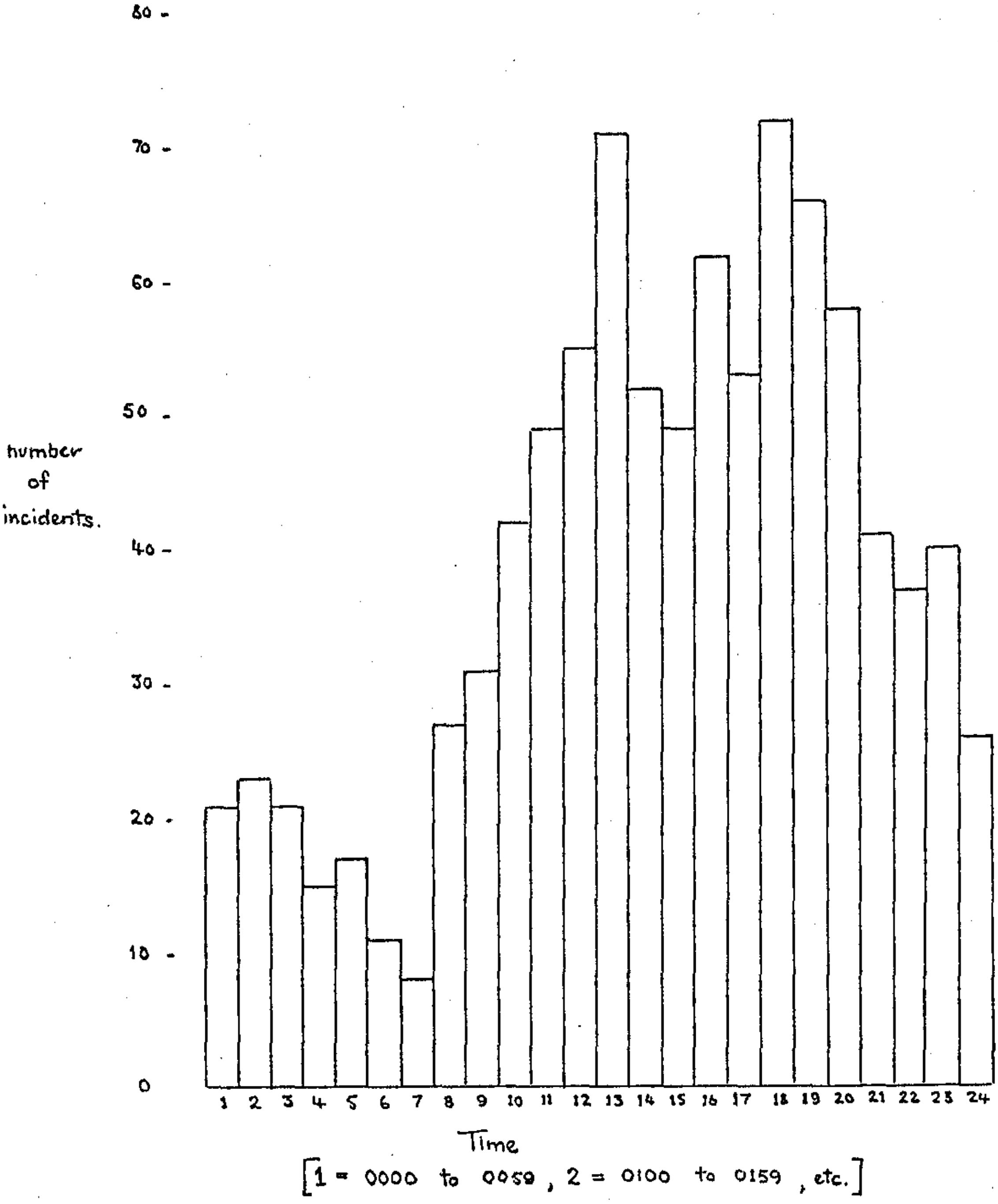

FIGURE 12. Frequency distribution of incidents by time

tend to be around mid-day and evening meal times (1200 to 1259 and 1700 to 1759), which is perhaps unsurprising when we consider that dwellings make up more than 60% of the sample. It does perhaps emphasise that fires associated with cooking appliances are a large proportion of all fires, a point we will discuss in more detail in Chapter 14.

With regard to Fire Severity, we would intuitively expect this to be closely related to any delay in discovering a fire, in other words, High severity fires would tend to be those which had been allowed chance to develop. On this basis, an immediate hypothesis is that fires which occur at night will be more severe than those which occur in the day. Before testing this hypothesis directly, we will first illustrate how Fire Severity is distributed with time over the 24 hour period. To do this we have used three of our severity measures, namely the number of Jets, the mean value of Smoke Density and the mean value of FSI. These distributions are illustrated in Figures 13, 14 and 15.

Inspection of Figures 13, 14 and 15 shows that each of the histograms differ in shape. Each has a different modal value. In Figure 15 , the percentage of incidents involving Jets, the mode occurs between 0600 and 0659, in Figure 14 , the mean FSI distribution, the mode is one hour earlier, 0500 to 0559, and in Figure 13, the mean Smoke Density distribution, the mode occurs between 0300 and 0359.

It will be noted that all three distributions differ markedly from the frequency distribution of fires against time in Figure 12. Thus the fires which occur most frequently are probably of Low severity on all our measures. In fact there appears to be an inverse relationship in terms of severity/frequency. For example, the modal categories for Jets, mean FSI and mean Smoke Density discussed above are based upon 0.8%, 1.1% and 1.6% respectively of the sample of 952 fires.

One further point which emerges from the study of Figures 13, 14 and 15 is that the overall levels do indeed appear to be rather higher during the night, and this is certainly the case between midnight and 0700.

Let us therefore now look at any differences which occur between daytime and night-time incidents in terms of Fire Severity. For the purposes of these analyses we have defined "Day" as between 0600 and 2159, and "Night" as 2200 through to 0559. Again we will test four of our severity measures: FSI level, Jets, Smoke Spread and Smoke Density.

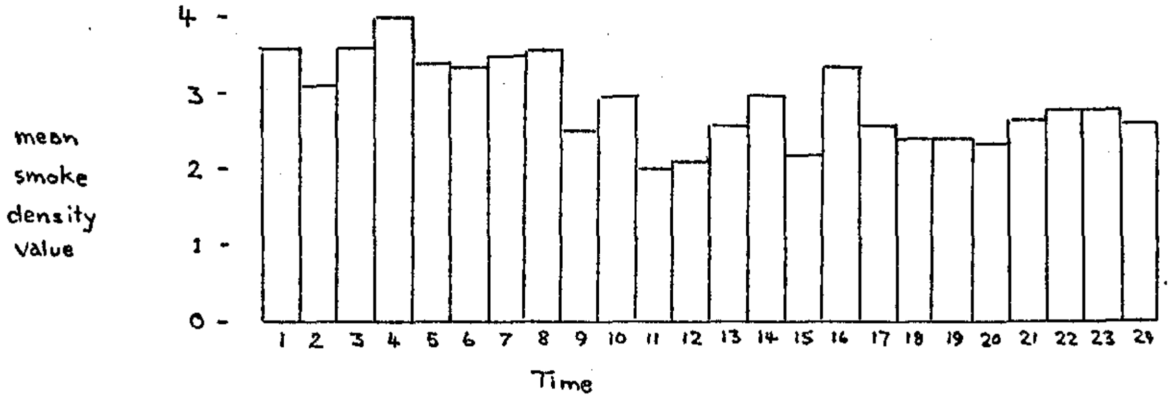

FIGURE 13. Mean Smoke Density by time

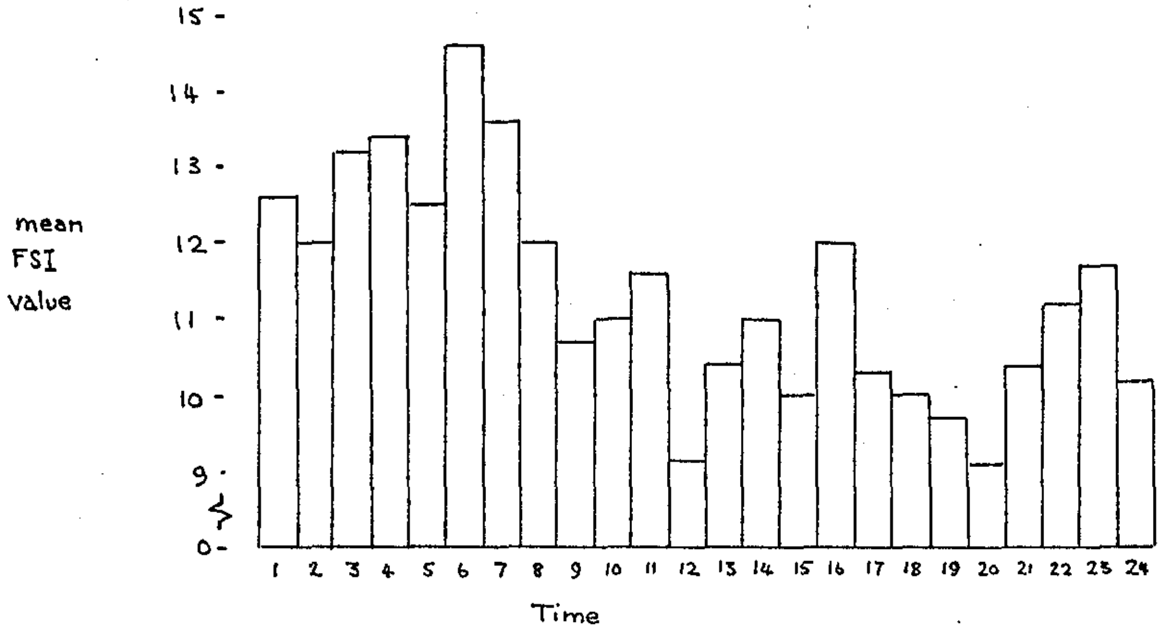

FIGURE 14. Mean FSI value by time

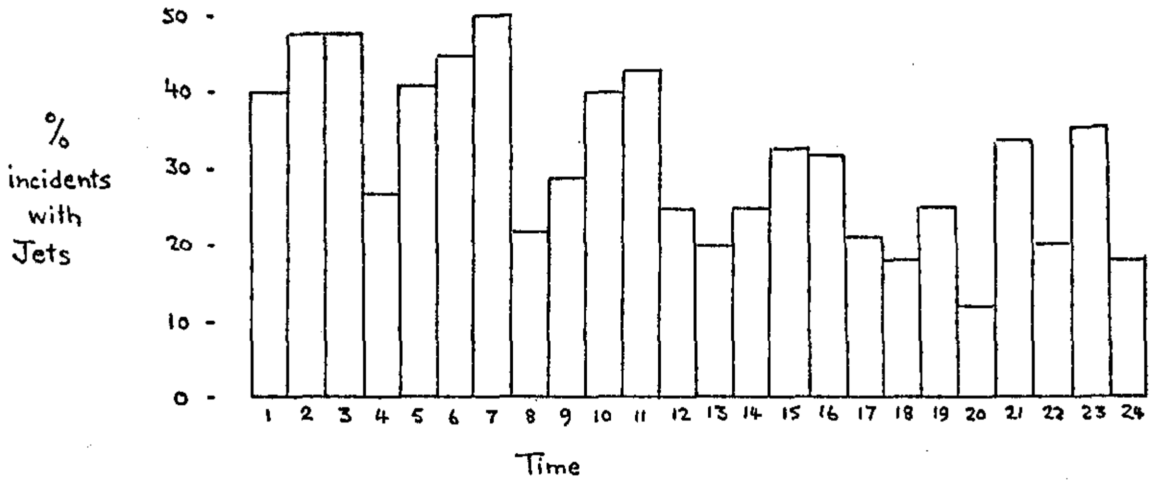

FIGURE 15. Percentage distribution of incidents requiring Jets by time

6.6.1 FSI LEVEL IN RELATION TO TIME OF THE INCIDENT

The distribution of FSI level against day and night-time incidents is shown in Table 22 overleaf. Inspection of this table shows that up to High levels of FSI, daytime incidents have a progressively smaller proportion of incidents, as FSI levels increase. This trend reverses slightly at the Very High level; however the overwhelming impression is that night-time incidents have higher levels of FSI. Testing directly on Table 22 gives a χ^2 value of 25.3 (4 df), which is significant beyond 0.0001. We may construct a 2 × 2 contingency table by dichotomising at the Medium level, and this is shown below.

Time	FSI level		Total
	Very Low to Low	Medium to Very High	
Day	464	314	778
Night	70	104	174
Total	534	418	952

χ^2 = 21.75 (1 df), significant beyond 0.001

We may thus state that night-time incidents have a significantly higher level of Fire Severity as measured by the Fire Severity Index.

6.6.2 USE OF JETS IN RELATION TO TIME OF THE INCIDENT

As before when using Jets as a measure of Fire Severity, it is simplest to divide incidents by whether or not Jets were used. The contingency table is shown below.

Time	No Jets	Jets	Total
Day	573	205	778
Night	108	66	174
Total	681	271	952

χ^2 = 8.8 (1 df), significant beyond 0.01

Thus again, incidents which occur at night are significantly more likely to be sufficiently severe to require a Jet to extinguish them.

TABLE 22. FSI level by night or day incidents

Time	FSI level					Total
	Very Low	Low	Medium	High	Very High	
Day	178 (22.9) (88.6)	286 (36.8) (85.9)	170 (21.9) (77.3)	73 (9.4) (69.5)	71 (9.1) (76.3)	778 (81.7)
Night	23 (13.2) (11.4)	47 (27.0) (14.1)	50 (28.1) (22.7)	32 (18.4) (30.5)	22 (12.6) (23.7)	174 (18.3)
Total	201 (21.1)	333 (35.0)	220 (23.1)	105 (11.0)	93 (9.8)	952 (100.0)

6.6.3 EXTENT OF SMOKE SPREAD IN RELATION TO TIME OF THE INCIDENT

For the purpose of considering the interaction of Smoke Spread with time, we have again divided Smoke Spread into two categories at the point where it spreads beyond the floor of origin. The contingency table is shown below.

Time	Smoke Spread		Total
	Up to floor of origin	Beyond floor of origin	
Day	582	196	778
Night	111	63	174
Total	693	259	952

χ^2 8.7 (1 df), significant beyond 0.01

It can be seen that incidents which occur at night are significantly more likely to have extensive Smoke Spread.

6.6.4 DENSITY OF THE SMOKE IN RELATION TO TIME OF THE INCIDENT

We have dichotomised Smoke Density at scale-value 3, as in earlier analyses. The contingency table is shown below.

Time	Smoke Density		Total
	scale-values 1 to 3	scale-values 4 to 7	
Day	520	258	778
Night	100	74	174
Total	620	332	952

$\chi^2 = 6.69$ (1 df), significant at 0.01

Incidents which occur at night are significantly more likely to have high levels of Smoke Density. We can thus see that comparing day and night incidents on each of our measures of Fire Severity tends to support our original hypothesis, that night-time incidents are more severe than daytime incidents.

6.7 FIRE SEVERITY MEASURES AND NUMBER OF STOREYS IN THE BUILDING

The majority of the buildings in the Present Study were of 2 or 3 storeys, and 92% (876) were of 4 storeys or less. The highly skewed nature of the distribution means that a complete cross-tabulation of storeys with any other variable has large numbers of blank cells. Similarly, it renders any decision regarding how to combine categories extremely difficult. If is clear, for example, that a 15-storey building is completely different in nature from a 5-storey building. We have thus chosen to divide storeys into four categories:

(a) Buildings up to 4 storeys high
(b) Buildings with 5 storeys
(c) Buildings with 6 to 16 storeys
(d) Buildings with more than 16 storeys.

The logic for this decision is based upon the earlier-cited definition of high-rise buildings (most usually dwellings), which are buildings of 5 or more storeys, usually with a lift. Since we do not know whether our 5 storey buildings contained lifts we have treated these separately. It is likely that all buildings over 5 storeys do have lifts. Before considering the relationship between Fire Severity and the number of storeys, we will first illustrate how the categories of building fall into our four categories above, and this is shown in Table 23 (p.105).

It can be seen from Table 23 that the biggest differences appear to occur between the Dwelling and Industrial categories of building, with Dwellings having a very large proportion less than 5 storeys, whereas the Industrial category has a smaller proportion of these low-rise buildings, and a disproportionately large number with 5 storeys. (These 5-storey Industrial category buildings were very often Cotton Mill buildings, and they occur in the sample so frequently due to the fact that both the Lancashire and West-Riding Fire Brigades were involved in data collection.)

As before, we will now consider the effect of several severity measures in relation to the number of storeys in the affected building. Since the values in so many cells are low or zero, we will in each case use the dichotomised categories for the severity measures.

6.7.1 FSI LEVEL IN RELATION TO NUMBER OF STOREYS IN THE BUILDING

The contingency table for FSI level against the number of storeys is shown below.

FSI level	Number of storeys				Total
	1 to 4	5	6 to 16	16+	
Very Low to Low	393	23	15	3	534
Medium to Very High	383	22	10	3	418
Total	876	45	25	6	952

$\chi^2 = 0.85$ (3 df), non-significant

It will be clear from inspection of the above table that there is little difference in the proportions. We can thus state that the level of the Fire Severity Index is not related to the number of storeys in the building.

6.7.2 USE OF JETS IN RELATION TO NUMBER OF STOREYS IN THE BUILDING

The contingency table showing the use or non-use of Jets against the number of storeys is shown below.

Use of Jets	Number of storeys				Total
	1 to 4	5	6 to 16	16+	
No Jets	637	24	17	3	681
Jets used	239	21	8	3	271
Total	876	45	25	6	952

$\chi^2 = 11.44$ (3 df), significant at 0.01

If we examine the contingency table for the source of association, it is clear that this occurs largely due to the number of "Jets" incidents in buildings of 5 storeys. Reference to Table 23 shows that 32 (71%) of the incidents in 5-storey buildings fall into our Industrial category which, as was shown in Section 6.2.1, have a disproportionately high number of Jets. This finding is therefore not surprising. Thus, although we may state that 5-storey buildings are significantly more

TABLE 23. Building category by number of storeys

Number of storeys	Building category					Total
	Dwelling	Industrial	Retail	Institution	Office/Other	
1 to 4	570 (65.1 (95.3)	158 (18.0) (80.6)	94 (10.7) (96.9)	35 (4.0) (89.7)	19 (2.2) (86.4)	876 (92.0)
5	11 (24.4) (1.8)	32 (71.1) (16.3)	1 (2.2) (1.0)	1 (2.2) (2.6)	0 (0.0) (0.0)	45 (4.7)
6 to 16	12 (48.0) (2.0)	6 (24.0) (3.1)	2 (8.0) (2.6)	3 (12.0) (7.7)	2 (8.0) (9.1)	25 (2.6)
16+	5 (83.3) (0.8)	0 (0.0) (0.0)	0 (0.0) (0.0)	0 (0.0) (0.0)	1 (16.7) (4.5)	6 (0.6)
Total	598 (62.8)	196 (20.6)	97 (10.2)	39 (4.1)	22 (2.3)	952 (100.0)

TABLE 24. Building category by number of people in the building

Number of people	Building category					Total
	Dwelling	Industrial	Retail	Institution	Office/Other	
less than 100	586 (65.6) (98.0)	165 (18.5) (84.2)	91 (10.2) (93.8)	30 (3.4) (76.9)	21 (2.4) (95.5)	893 (93.8)
more than 100	12 (20.3) (2.0)	31 (52.5) (15.8)	6 (10.2) (6.2)	9 (15.3) (23.1)	1 (1.7) (4.5)	59 (6.2)
Total	598 (62.8)	196 (20.6)	97 (10.2)	39 (4.1)	22 (2.3)	952 (100.0)

likely to require Jets, this is probably a result of the buildings in this category in our Present Sample, and the finding is not generalisable.

6.7.3 EXTENT OF SMOKE SPREAD IN RELATION TO NUMBER OF STOREYS IN THE BUILDING

The contingency table showing Smoke Spread up to and beyond the floor of origin against the number of storeys in the building is shown below.

Smoke Spread	Number of storeys				Total
	1 to 4	5	6 to 16	16+	
Up to floor of origin	639	31	19	4	681
Beyond floor of origin	237	14	6	2	271
Total	876	45	25	6	952

$\chi^2 = 0.6$ (3 df), non-significant

We may therefore state that the extent of Smoke Spread is not related to the number of storeys in the building.

6.7.4 DENSITY OF SMOKE IN RELATION TO NUMBER OF STOREYS IN THE BUILDING

The contingency table showing Smoke Density, dichotomised into scale-values up to 3, and scale-values over 3, against the number of storeys in the building is shown below.

Smoke Density scale-values	Number of storeys				Total
	1 to 4	5	6 to 16	16+	
1 to 3	568	30	19	3	620
4 to 7	308	15	6	3	332
Total	876	45	25	6	952

$\chi^2 = 1.98$ (3 df), non-significant

The density of the smoke is also not related to the number of storeys in the building.

Thus, with the exception of the number of Jets, all our measures of Fire Severity are not related to the number of storeys in the building. As was mentioned earlier, the fact that "Jets" reaches a significant level is probably due to the large number of 5-storey Cotton Mills (which often required Jets) in the sample of incidents in this category.

6.8 FIRE SEVERITY MEASURES AND NUMBER OF PEOPLE IN THE BUILDING

Many of the earlier-cited anecdotal accounts of building "panic" incidents occurred in buildings in which large numbers of people were present. Whilst the sample of incidents in the Present Study has a large proportion of incidents with only 2 or 3 people present, it was considered of interest to examine the effect of the presence of large numbers of people on the other variables. For the purposes of these analyses, we have chosen to define "a large number of people" as more than 100, and consequently have dichotomised our sample into incidents which have less than 100 people in the building, and those which have more than 100 people in the building. As before, we will illustrate how these categories are distributed across building categories, and this is shown in Table 24 (p.105). We will then examine the effects of the Fire Severity variables.

It can be seen from Table 24 (p.105) that the frequency of incidents with more than 100 people is unevenly distributed between building categories ($\chi^2 = 68.4$ (4 df), significant beyond 0.001), the source of this discrepancy being the relatively large number of Industrial buildings with more than 100 people involved.

We will again use four measures of Fire Severity, namely: FSI level, Jets, Smoke Spread and Smoke Density.

6.8.1 FSI LEVEL IN RELATION TO NUMBER OF PEOPLE IN THE BUILDING

The contingency table of FSI level against the number of people in the building is shown overleaf. Examination of this table shows that incidents with more than 100 people in the building tend to have a significantly lower proportion of high FSI values.

FSI level	Number of people		Total
	less than 100	100 or more	
Very Low to Low	489	45	534
Medium to Very High	404	14	418
Total	893	59	952

χ^2 = 10.3 (1 df), significant beyond 0.01

6.8.2 USE OF JETS IN RELATION TO NUMBER OF PEOPLE IN THE BUILDING

The contingency table for the use or non-use of Jets against the number of people in the building is shown below.

Use of Jets	Number of people		Total
	less than 100	100 or more	
No Jets	637	44	681
Jets used	256	15	271
Total	893	59	952

χ^2 = 0.28 (1 df), non-significant

Thus whether or not Jets were used is not related to the number of people in the building. Intuitively, this is rather surprising, as it has been noted from Table 24 that buildings in the Industrial category make up a large proportion of those with more than 100 people present, and as we have seen, Industrial category buildings tend to have a greater proportion of Jets.

6.8.3 EXTENT OF SMOKE SPREAD IN RELATION TO NUMBER OF PEOPLE IN THE BUILDING

The contingency table for Smoke Spread, up to and beyond the floor of origin, against the number of people in the building is shown overleaf. It can be seen that the χ^2 value fails to reach the 0.01 probability level, and we must conclude that the extent of Smoke Spread is independent of the number of people in the building.

Smoke Spread	Number of people		Total
	less than 100	100 or more	
Up to floor of origin	643	50	693
Beyond floor of origin	250	9	259
Total	893	59	952

χ^2 = 4.53 (1 df), non-significant

6.8.4 DENSITY OF SMOKE IN RELATION TO NUMBER OF PEOPLE IN THE BUILDING

The contingency table for Smoke Density (dichotomised) against the number of people in the building is shown below.

Smoke Density scale-values	Number of people		Total
	less than 100	100 or more	
1 to 3	573	50	623
4 to 7	320	9	329
Total	893	59	952

χ^2 = 6.85 (1 df), significant at 0.01

Again, it can be seen that it is the buildings with less than 100 people present in which Smoke Density values tend to be higher.

6.9 DISCUSSION

As was inferred at the beginning of this chapter, the problem of deriving a suitable measure for the severity of the fire is not a simple one. It is, at least partially, a problem of definition. What do we mean when we talk of serious, or severe fires? Are we discussing the threat to life? If so, then measures of Smoke Spread, Smoke Density and perhaps the toxic constituents of smoke are by far the most relevant, since in fires, these variables are directly responsible in most cases for the death of a building occupant. People hardly ever die from burns alone; they are overcome by smoke and die of carbon monoxide poisoning.

If not threat to life, then perhaps some measure of the physical combustion process, the fierceness of the flames or intensity of heat, is implied. Clearly these aspects cannot be measured directly in real-life fire situations. In any case such factors are inextricably bound-up with the nature of the building, the materials from which it is constructed and the presence of inflammable objects. Differences in these will also alter the extent to which the fire spreads, how much of the structure is involved and whether other buildings are at risk.

We have seen in Section 6.4 that our primary measures of severity, Fire Spread, use of Fire Brigade equipment and smoke characteristics give different answers in different categories of building. This may be for two possible, connected, reasons. Firstly, they are measuring different aspects of the fire, which are not necessarily related, and secondly, the nature of fires in different categories of building varies. Whilst we have no hard evidence to support them, it is felt that both of these explanations may be true. Thus Dwelling fires have a disproportionately low number of incidents requiring Jets, and also have disproportionately high levels of Smoke Spread and Smoke Density. The use of Jets is probably associated with high intensity fires in terms of heat, flames, and perhaps Fire Spread; these particular characteristics of the fire <u>not necessarily</u> being associated with dense or extensive smoke. The opposite characteristics are manifest in Industrial fires which have a disproportionately large number of Jets, and low values of the smoke variables. It is relatively easy to think of reasons why there should be this discrepancy, considering the different types of building. For example, the substances and equipment present in Industrial buildings must often present a greater hazard in terms of intense combustion, which would explain the high level of Jets. In addition, Industrial buildings are usually larger than Dwellings, so that any smoke present will become more diffuse, and thus have a lower estimated density. In contrast, dwellings have many different types of soft-furnishing present which tend to smoulder and produce large volumes of smoke. Within the restricted confines of a house or flat this soon becomes very dense, and will spread rapidly through an open door to the upper storeys.

It seems, therefore, that the measures utilised in the Present Study may well be providing accurate information on the seriousness of the fire. They cannot, however, be treated in isolation, since each is recording a specific aspect of Fire Severity, rather than an overall measure. Following on from this we would suggest that fires in different building categories differ intrinsically in their nature, some scoring high on Smoke variables and some high on fire intensity. Which category of building has the most severe fires is an unanswerable question, unless we define what we mean, which brings us back to our original problem.

As the measures are so specific, the need was felt to have a single, comprehensive metric for Fire Severity. This rationale led to the derivation of the Fire Severity Index (FSI), which included all the known information on the nature of the fire. The development of such a severity index is not, of course, a novel idea. Perhaps one of the most well known is the US Consumer Product Hazard Index (US Consumer Product Safety Commission, 1975). This index was established so that the hazard presented by any particular product could be quantified and ranked, in order that decisions on safety expenditure may be made on a defensible and rational basis. The development and method of calculation of the index are of interest, and will be briefly described.

The Hazard Index is based firmly upon the number and severity of injuries recorded. Severity is evaluated in terms of injury diagnosis, body part affected, and whether hospitalisation was required. The severity ranking was developed by analysing more than 250 reasonable combinations of diagnoses and affected body parts, and assigning each combination to a severity category from 1 to 6. If the injury required hospitalisation, the rating was increased by 1. Thus, an injury with a severity rating of 6 which required hospitalisation would be placed in category 7. Category 8 was used to record a known fatality.

However, the trauma associated with the increased categories of severity did not seem satisfactorily represented by a simple linear description of severity (1,2,...7). It was felt that the injuries in the higher categories (5, 6, and 7) by their very nature deserved a much more pronounced weight. It was decided by the Consumer Product Safety Commission to relate the categories by using a geometric progression starting from an initial value of 10. The seven categories then relate to each other as follows: 10, 12, 17, 31, 81, 340, 2516 from category 1 to 7 respectively. Category 8 was also assigned 2516.

Before ranking the product categories, the Commission included one additional factor, the age of the victim, to provide special consideration for the young due to the nature of the risks incurred by this group. Combining the number and severity of injuries, and including the age of the victim, produces a metric which is termed the Age Adjusted Frequency Index (AFSI).

AFSI was derived by multiplying the estimate of the numbers of injuries treated in emergency rooms for a product category by the mean severity of these injuries, and then multiplying this by 2.5 for the injuries occurring to children (0 - 14 years). The latter was done to arbitrarily increase the weighted severity for the age-14 and younger population in relation to the age-15 and older population. Finally all such weighted injury severity values were summed. This sum was then divided by 1 million, and the last three digits of the resulting number were truncated to obtain the AFSI index number. The Age Adjusted Frequency Severity Index (AFSI) thus provides a means for ranking consumer products.

Clearly this is a much more complex procedure than our calculation of the Fire Severity Index. However the underlying rationale is similar, in that both indices attempt to weight certain factors so that particular types of incident will be given prominence.

Having invested considerable effort in deriving FSI, it regrettably fails to provide us with an answer to the question "which building category has the most severe fires?". Clearly our weighting process has neatly balanced high-Jets/low-smoke incidents with low-Jets/high-smoke incidents. We do not feel this renders the FSI as valueless, but rather that the question of building category and Fire Severity cannot be answered in a simple unitary way, as was pointed out earlier in this discussion.

A very great advantage which accrues from calculating FSI is that it facilitates the scaling of fires on a much broader range of values, 44 in the case of raw FSI and 5 in the case of the level of FSI. We will therefore continue to use it in comparing incidents, but only in conjunction with other measures of severity such as the number of Jets and the measures of smoke characteristics.

With regard to the time of occurrence of the incident, we have seen that night-time fires tend to be more severe on all counts. This is not surprising if we consider that, ultimately, Fire Severity must be very closely related to the period of time for which the fire is allowed to develop undiscovered. This delay, between occurrence and discovery, is almost certain to be longer at night.

Our comparisons with other Building variables were made essentially to explore particular hypotheses regarding tall buildings and buildings with large numbers of occupants. In the case of the number of storeys in the building, the significant relationship between the number of Jets and five-storey Industrial buildings is probably an artefact of this particular sample. On the basis of all our measures of Fire Severity, buildings with large numbers of people do not present a particularly grave hazard. Indeed on our chosen classifications, it is buildings with less than 100 people which have significantly higher levels of Smoke Density, this finding probably reflecting the association between Dwellings and high values of this variable.

CHAPTER 7

INCIDENTS INVOLVING RESCUES, INJURIES & FATALITIES

7.0 INCIDENTS INVOLVING RESCUES, INJURIES AND FATALITIES

The variables considered in this section are rather different from those discussed in the preceding chapter. Those considered earlier all relate in a variety of ways to the physical nature of the fire, whereas the occurrence of rescues, injuries or fatalities are a consequence of the fire. Nonetheless, the extent to which these "consequences" occur may also be regarded as a measure of the seriousness of the fire, if only for pragmatic reasons. As was observed in the Introduction, many of the earlier, anecdotal accounts of fire are concerned with incidents in which large numbers of people were either rescued, injured or killed. It is such incidents, however rare, which are likely to bring into question the adequacy of current Codes of Practice in relation to fire. It is also likely that most people would regard any fatal fire, for example, as more "serious" than one which did not involve casualties, however highly the non-casualty incident scored on our earlier-discussed measures of Fire Severity. Whilst it is clear that in doing this they are using a different dimension for measuring severity, we must recognise that this is a completely valid standpoint and include this dimension in our assessment.

In the Present Study there were 14 incidents involving rescues, 56 incidents involving injuries, and 7 incidents involving fatalities. The breakdown of these incidents is illustrated in Figure 16. It will be noted from Figure 16 that 885 (92.9%) of the incidents involved neither a rescue, an injury or a fatality. It is also evident that the majority of Injury incidents were non-rescue incidents, and 4 of the 7 fatalities involved neither injuries nor rescues.

Hereafter, where we are discussing incidents which involved either rescues, injuries or fatalities as a group, we will abbreviate the group title to "RIF" incidents. Similarly, the group of incidents which did not involve a rescue, injury or fatality will be abbreviated to "non-RIF" incidents.

In the following sections we will analyse how RIF incidents are distributed across building categories, and examine their relationship to other measures of Fire Severity. Qualitative aspects of these incidents are examined in Chapters 14, 15 and 16.

FIGURE 16. Breakdown of incidents by the occurrence of Rescues, Injuries and Fatalities

Whole sample of incidents N = 952	Non-Rescue incidents N = 938	Non-Injury incidents N = 889	Non-Fatal incidents N = 885
			Fatal incidents N = 4
		Injury incidents N = 49	Non-Fatal incidents N = 48
			Fatal incidents N = 1
	Rescue incidents N = 14	Non-Injury incidents N = 7	Non-Fatal incidents N = 6
			Fatal incidents N = 1
		Injury incidents N = 7	Non-Fatal incidents N = 6
			Fatal incidents N = 1

7.1 RIF INCIDENTS IN RELATION TO BUILDING CATEGORY

For the initial tabulation in this section only, we have chosen to revert to the original breakdown of building categories into 20 separate types. This has been done so that we may identify specific occupancies in which these incidents occur. It will have been noted from Figure 16, that rescues, injuries and fatalities are not mutually-exclusive categories. Where an incident involved some combination of these it will thus be represented under each heading. Table 25 shows the distribution of RIF and Non-RIF fires across the various building categories.

TABLE 25. RIF and non-RIF incidents by building category (using the original breakdown of building categories)

Building category	Non-RIF incidents	RIF incidents		
		Rescues	Inuries	Fatalities
Dwelling house	446	5	30	5
Factory	155	1	4	1
Block of flats	50	3	8	1
Multi-occupancy	35	2	7	-
School	7	-	-	-
Hotel	6	1	1	-
College	3	-	-	-
Shop (unspecified)	54	2	2	-
Public house	13	-	-	-
Fish and chip shop	11	-	-	-
Garage	16	-	2	-
Warehouse/store	14	-	1	-
Cafe/restaurant	10	-	1	-
Launderette	5	-	-	-
Hostel/home	10	-	-	-
Office	6	-	-	-
Flat over shop, etc	12	-	-	-
Hospital	12	-	-	-
Boiler house	4	-	-	-
Other	16	-	-	-
Total	885	14	56	7

It can be seen that RIF fires are distributed very unevenly across the building categories. The most striking points which illustrate this are as follows:

(a) Blocks of flats, which represent only 6.4% (61) of the total 952 incidents, have 25.0% of the Injury fires.

(b) Multi-occupancy dwellings, representing only 4.4% (42) of the total 952 incidents, have 11.9% of the Injury fires.

(c) Factories, which represent some 16.7% (159) of the total 952 incidents, have only 3.8% of the injury fires.

(d) Six of the seven fatal fires are in buildings which may be categorised as Dwellings.

The increased hazard associated with Dwelling fires shown in (d) above is illustrated even more clearly if we combine our building categories as has been done earlier. This is shown in Table 26 below.

TABLE 26. RIF and Non-RIF incidents by building category (using revised categories)

Building category	Non-RIF incidents	RIF incidents		
		Rescues	Injuries	Fatalities
Dwelling	543	10	45	6
Industrial	189	1	7	1
Retail	93	2	3	0
Institution	38	1	1	0
Office/Other	2	0	0	0
Total	885	14	56	7

Apart from the 6 out of 7 fatal fires already mentioned, inspection of Table 26 reveals that Dwelling fires have in addition, 86.5% of the Injury fires and 84.6% of the incidents which involved a Fire Brigade rescue. The combined Dwelling category shown in Table 26 represents 57.1% of the total incidents. Conversely, Industrial fires (20% of the overall incidents) have only 9.3% of the Injury fires.

It can thus be seen that in the Present Study, Dwellings have a disproportionately high number of fires which involved Rescues, Injuries or Fatalities, whereas Industrial occupancies had a disproportionately low number of these incidents. If we regard the occurrence of a rescue, an injury or a fatality at an incident as a measure of Fire Severity, then Dwelling fires are more severe than other building categories, and Industrial fires are less severe than other building categories.

7.2 RIF INCIDENTS IN RELATION TO OTHER MEASURES OF FIRE SEVERITY

We have chosen to compare RIF and Non-RIF incidents on the basis of four other measures of Fire Severity, namely Jets, Smoke Spread, Smoke Density and FSI level.

7.2.1 FSI LEVEL IN RELATION TO RIF INCIDENTS

Table 27 below shows the level of the Fire Severity Index in relation to RIF incidents. It can be seen that Non-RIF incidents have a progressively smaller proportion of each FSI level as this increases, whereas Rescues are concentrated between Medium and Very High FSI levels, and Fatalities between High and Very High levels. The Injuries category is somewhat more evenly distributed with nearly 36% of the Injury incidents occurring at Low or Very Low levels.

TABLE 27. Non-RIF and RIF incidents by FSI level

FSI level	Non-RIF incidents	RIF incidents			Total
		Rescues	Injuries	Fatalities	
Very Low	196 (97.5) (22.1)	0 (0.0) (0.0)	5 (2.5) (8.9)	0 (0.0)	201 (21.1)
Low	318 (95.5) (35.9)	0 (0.0) (0.0	15 (26.8)	0 (0.0)	333 (35.0)
Medium	205 (93.2) (23.2)	2 (0.9) (14.3)	13 (5.9) (23.2)	0 (0.0)	220 (23.1)
High	90 (85.7) (10.2)	6 (5.7) (42.9)	10 (9.5) (17.9)	3 (2.9) (42.9)	105 (11.0)
Very High	76 (81.7) (8.6)	6 (6.5) (42.9)	13 (14.0 (23.2)	4 (4.3) (57.1)	93 (9.8)
Total	885 (93.0)	14 (1.5)	56 (5.9)	7 (0.7)	952 (100.0)

Since as we have seen in Figure 16, Rescues, Injuries and Fatalities are not independent categories, we cannot test directly on the data in Table 27. We can however test the categories separately, and this is shown in the following contingency tables.

	FSI level					Total
	Very Low	Low	Medium	High	Very High	
No Rescues	201	333	218	99	87	938
Rescues	0	0	2	6	6	14
Total	201	333	220	105	93	952

χ^2 = 37.4 (4 df), signifcant beyond 0.0001

	FSI level					Total
	Very Low	Low	Medium	High	Very High	
No Injuries	196	318	207	95	80	896
Injuries	5	15	13	10	13	56
Total	201	333	220	105	93	952

$\chi^2 = 18.8$ (4 df), significant beyond 0.001

It is not possible to test the Fatalities category as it contains no values below High; however it is clear that the incidence of Fatalities is also associated with much higher levels of FSI. We can thus confidently state that incidents which involve Rescues, Injuries or Fatalities have significantly higher levels of Fire Severity.

7.2.2 USE OF JETS IN RELATION TO RIF INCIDENTS

We will now examine whether or not Jets were used at RIF incidents, and this is shown in Table 28 below.

TABLE 28. RIF and Non-RIF incidents by use of Jets

Use of Jets	Non-RIF incidents	RIF incidents			Total
		Rescues	Injuries	Fatalities	
Jets	644 (94.6) (72.8)	5 (0.7) (35.7)	33 (4.8) (58.9)	1 (0.1) (14.3)	681 (71.5)
Jets used	241 (88.9) (27.2)	9 (3.3) (64.3)	23 (8.5) (41.1)	6 (2.2) (85.7)	271 (28.5)
Total	885 (93.0)	14 (1.5)	56 (5.9)	7 (0.7)	952 (100.0)

Inspection of Table 28 shows again that it is the Rescues and Fatalities categories which have high proportions of incidents where Jets were utilised. As before we will test each group separately. The contingency tables are set out overleaf.

Use of Jets	No Rescues	Rescues	Total
No Jets	676	5	681
Jets	262	9	271
Total	938	14	952

$\chi^2 = 7.2$ (1 df), significant beyond 0.01

Use of Jets	No Injuries	Injuries	Total
No Jets	648	33	681
Jets	248	23	271
Total	896	56	952

$\chi^2 = 4.00$ (1 df), non-significant

Use of Jets	No Fatalities	Fatalities	Total
No Jets	680	1	681
Jets	265	6	271
Total	945	7	952

χ^2(using Fishers exact test) = 8.69 (1 df),
significant beyond 0.01

We can see that in each case the RIF categories have a greater proportion of incidents involving Jets, although in the case of Injury incidents χ^2 fails to reach the 0.01 level. Thus, using Jets as our measure of Fire Severity, incidents involving Rescues and Fatalities are significantly more severe, whilst incidents involving Injuries are independent of Fire Severity.

7.2.3 EXTENT OF SMOKE SPREAD IN RELATION TO RIF INCIDENTS

We will now examine the extent of Smoke Spread in RIF incidents, and this is shown in Table 29 overleaf. Again it can be seen that the Non-RIF category has a progressively smaller proportion of incidents as the Smoke Spread increases. As was stated earlier, it is considered that the critical point for Smoke Spread is where it spreads beyond the floor of origin, and we have selected this as the dividing point for the contingency tables.

TABLE 29. RIF and Non-RIF incidents by extent of Smoke Spread

Smoke Spread	Non-RIF incidents	RIF incidents			Total
		Rescues	Injuries	Fatalities	
Little or none	111 (97.4) (12.5)	0 (0.0) (0.0)	3 (2.6) (5.3)	0 (0.0) (0.0)	114 (12.0)
Room of origin	310 (96.6) (35.0)	0 (0.0) (0.0)	11 (3.4) (19.6)	0 (0.0) (0.0)	321 (33.7)
Floor of origin	240 (93.0) (27.0)	3 (1.2) (21.4)	15 (5.8) (26.8)	1 (0.4) (14.3)	258 (27.1)
Floor above	178 (88.6) (20.1)	6 (3.0) (42.8)	19 (9.5) (33.9)	3 (1.5) (42.8)	201 (21.1)
More extensive	46 (79.3) (5.2)	5 (8.6) (35.7)	8 (13.8) (14.3)	3 (5.2) (42.8)	58 (6.1)
Total	885 (93.0)	14 (1.5)	56 (5.9)	7 (0.7)	952 (100.0)

Smoke Spread	No Rescues	Rescues	Total
Up to floor of origin	690	3	693
Beyond floor of origin	248	11	259
Total	938	14	952

$\chi^2 = 18.9$ (1 df), significant beyond 0.001

Smoke Spread	No Injuries	Injuries	Total
Up to floor of origin	664	29	693
Beyond floor of origin	232	27	259
Total	896	56	952

$\chi^2 = 13.2$ (1 df), significant beyond 0.001

Smoke Spread	No Fatalities	Fatalities	Total
Up to floor of origin	692	1	693
Beyond floor of origin	253	6	259
Total	945	7	952

$\chi^2 = 12.2$ (1 df), significant beyond 0.001

It can thus be seen that incidents which involve Rescues, Injuries or Fatalities have significantly more extensive Smoke Spread.

7.2.4 DENSITY OF SMOKE IN RELATION TO RIF INCIDENTS

Finally, we will examine Smoke Density in relation to RIF incidents, and this is illustrated in Table 30 overleaf. Again we note that the Non-RIF category has a progressively smaller proportion of incidents as Smoke Density increases, although the absolutely consistent fall noted in earlier tables is distributed by the reversal of the proportions at Smoke Density values 6 and 7. We have elected to construct our contingency tables around the mid-point of Smoke Density, at scale-value 3, and these are presented below.

Smoke Density scale-value	No Rescues	Rescues	Total
1 to 3	618	2	620
4 to 7	320	12	332
Total	938	14	952

$\chi^2 = 16.1$ (1 df), significant beyond 0.001

Smoke Density scale-value	No Injuries	Injuries	Total
1 to 3	597	23	620
4 to 7	299	33	332
Total	896	56	952

$\chi^2 = 15.1$ (1 df), significant beyond 0.001

Smoke Density scale-value	No Fatalities	Fatalities	Total
1 to 3	618	2	620
4 to 7	327	5	332
Total	945	7	952

$\chi^2 = 4.14$ (1 df), non-significant

Incidents which involve Rescues or Injuries have significantly higher values of Smoke Density, whilst incidents which involve Fatalities do not.

TABLE 30. RIF and Non-RIF incidents by Smoke Density

Smoke Density scale-values	1	2	3	4	5	6	7	Total
Non-RIF incidents	288 (32.6) (96.6)	146 (16.5) (96.1)	160 (18.1) (94.1)	130 (14.7) (90.3)	95 (10.7) (88.0)	40 (4.5) (81.6)	26 (2.9) (83.9)	885 (93.0)
Rescues	0 (0.0) (0.0)	0 (0.0) (0.0)	2 (14.3) (1.2)	3 (21.4) (2.0)	5 (35.7) (4.6)	2 (14.3) (4.1)	2 (14.3 (6.5)	14 (1.5)
Injuries	10 (17.6) (3.4)	6 (0.0) (3.9)	7 (12.5) (4.1)	13 (23.2) (8.9)	9 (16.1) (8.3)	7 (12.5) (14.3)	4 (7.1) (12.9)	56 (5.9)
Fatalities	0 (0.0) (0.0)	0 (0.0) (0.0)	2 (28.6) (1.2)	0 (0.0) (0.0)	1 (14.3) (0.9)	3 (42.9) (6.1)	1 (14.3) (3.2)	7 (0.7)
Total	298 (31.3)	152 (16.0)	170 (17.9)	146 (15.1)	108 (11.3)	49 (5.1)	31 (3.3)	952 (100.0)

Although we have seen that RIF incidents have significantly more severe fires on all our measures of Fire Severity, we have not made comparisons within the RIF category. The simplest way of doing this is to compute the mean values of FSI, Jets and Smoke Density, and these are shown in Table 31. It should be remembered that these are ordinal scales and they may thus only be compared in terms of order.

TABLE 31. Mean values of Fire Severity measures for RIF and Non-RIF incidents.

	Non-RIF incidents	RIF incidents		
		Rescues	Injuries	Fatalities
Number of incidents	885	14	56	7
Number of Jets	323	13	38	12
Mean Jets/incidents	0.37	0.93	0.68	1.71
Mean FSI value	10.6	19.1	14.0	23.0
Mean Smoke Density	2.71	4.93	3.7	5.14

On this basis it can be seen that incidents involving Fatalities have the most severe fires, Rescue incidents the next most severe, and Injury incidents the next. All are considerably more severe than Non-RIF incidents.

7.3 RIF INCIDENTS AND TIME OF THE INCIDENT

As we cannot test directly on a cross-tabulation of RIF and Non-RIF incidents against time, we will treat each category separately. The contingency tables are appended below.

Time	No Rescues	Rescues	Total
Day	770	8	778
Night	168	6	174
Total	938	14	952

χ^2(using Fishers exact test) = 4.19 (1 df),
non-significant

Time	No Injuries	Injuries	Total
Day	736	42	778
Night	160	14	174
Total	896	56	952

χ^2(using Fishers exact test) = 1.35 (1 df),
non-significant

Time	No Fatalities	Fatalities	Total
Day	775	3	778
Night	170	4	174
Total	945	7	952

χ^2(using Fishers exact test) = 4.85 (1 df),
non-significant

From the preceding three tables it can be seen that in each case the occurrence of RIF incidents is independent of the time at which the fire occurred in terms of night or day.

7.4 RIF INCIDENTS AND NUMBER OF STOREYS IN THE BUILDING

As in earlier sections, we will test RIF and Non-RIF incidents in each individual category. The contingency table for RIF incidents against the number of storeys in the affected building is shown below.

Number of storeys	1 to 4	5	6 to 16	16+	Total
No Rescues	866	42	24	6	938
Rescues	10	3	1	0	14
Total	876	45	25	14	952

Testing directly on this table would be unwise, as a large number of the cells have expected values under 5. We have therefore combined categories in the manner shown overleaf.

Number of storeys	1 to 4	5 or more	Total
No Rescues	866	72	938
Rescues	10	4	14
Total	876	76	952

$\chi^2 = 8.19$ (1 df), significant beyond 0.001

Unsurprisingly, the occurrence of Rescues is more likely to occur in buildings which are over 4 storeys high.

As the number of Injury incidents is also small, we have omitted the full cross-tabulation and dichotomised storeys as above. The contingency table is shown below.

Number of storeys	1 to 4	5 or more	Total
No Injuries	826	70	896
Injuries	50	6	56
Total	876	76	952

$\chi^2 = 0.60$ (1 df), non-significant

With only 7 Fatal incidents, significance testing is not feasible; however the tabulation for these incidents is shown below.

Number of storeys	2	3	5	Total
Fatalities	3	3	1	7

It can be seen that 6 of the 7 incidents occurred in two or three-storey buildings, the 1 five-storey building which involved a fatality being a Cotton mill.

We find that the occurrence of Injury incidents is independent of the number of storeys, whereas Rescue incidents are more likely to occur in buildings over 4 storeys, and Fatal incidents more likely to occur in buildings of less than 4 storeys.

7.5 RIF INCIDENTS AND NUMBER OF PEOPLE IN THE BUILDING

The contingency tables for Rescue and Injury incidents in relation to the number of people in the building are shown below.

Number of people	less than 100	100 or more	Total
No Rescues	881	57	938
Rescues	12	2	14
Total	893	59	952

$\chi^2 = 0.49$ (1 df), non-significant

Number of people	less than 100	100 or more	Total
No Injuries	840	56	896
Injuries	53	3	56
Total	893	59	952

$\chi^2 = 0.00$ (1 df), non-significant

Thus both Rescue and Injury incidents are independent of the presence of large numbers of people in the building.

As earlier, we will tabulate the Fatal incident frequencies exactly, and these appear below.

Number of people in building	2	3	7	15	200	Total
Fatalities	2	2	1	1	1	7

The above tabulation reflects the finding that 6 of the Fatal incidents in the Present Study occurred in buildings which are categorised as Dwellings, the seventh (with 200 occupants), being, as already stated, in a Cotton mill.

7.6 DISCUSSION

It is possible to treat the findings of this chapter in two ways. We could, as was discussed at the beginning of the chapter, consider the occurrence of a rescue, an injury or fatality as yet a further measure of Fire Severity. On this basis we would examine and compare the relative occurrence of RIF and Non-RIF incidents in relation to other variables and assign "levels of severity" based upon these.

More realistically, we can treat Rescues, Injuries and Fatalities as a special category of incident,* and interpret their occurrence in terms of their association with other variables. In other words, RIF incidents may be treated as either the "dependent" or "independent" variable. In this discussion we have chosen the latter course. With regard to this decision, it should be noted that we have, in this Chapter, restricted our examination of the interaction of variables to those concerned with the Building and the Fire. The effect of Personal and Behavioural variables in RIF incidents will be discussed in detail in Chapters 14, 15 and 16.

The first point of note is that RIF incidents are much more likely to occur in Dwellings than in other types of occupancy. This may simply be a function of the extent of exposure, since Dwellings tend to be occupied for longer periods of the day than other types of building. However, duration of exposure is unlikely to be a complete explanation, certainly in terms of Injury incidents where the level of hazard, that is the range of potential fire situations, is probably much greater in other occupancies. In this case it is likely that behavioural differences between the home environment and the work environment, for example, may be of importance.

With regard to the time of the incident, it is interesting to note that in each case there are proportionately more RIF incidents at night, although the differences fail to reach the 1% level. Had we been prepared to accept the 5% level as indicating the reality of the relationship, then the occurrence of both Rescues and Fatalities would be seen to be associated with night-time incidents, whereas Injury incidents are clearly independent of time of day.

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* These incidents were of course examined in greater detail than Non-RIF incidents as an adjunct to the main study.

Similarly with the number of storeys in the building, Injury incidents are again not related to this variable. Since by definition a rescue will only occur when a person is unable to leave the building by their own efforts, we could have predicted with some confidence that these are more likely to occur in buildings with more than 4 storeys. Our group of Fatal incidents tends to be clustered in the 3 to 4 storey category, reflecting their already-discussed association with dwellings.

The occurrence of RIF incidents appears to be unrelated to the number of people in the building, although this may reflect the particular categorisation of the "number of people", which was chosen specifically to examine whether or not incidents with "large numbers" of people were associated with Rescues, Inuries or Fatalities. On the basis of these analyses, they clearly were not.

Finally we turn to the severity of fire in RIF incidents. In this case, although the findings are not completely unanimous, there are strong indications that Rescues, Injuries and Fatalities are all associated with High levels of severity. If we attempt to order them, we find that Fatal incidents tend to have the highest level of Fire Severity, Rescues the second highest, and Injuries the third highest. We may tentatively generalise from this, suggesting that in some ways Rescue and Fatal incidents are fairly similar, whereas Injury incidents have little in comon with the other two, either in their cause or aetiology.

We might regard Fatal incidents as unattempted/unsuccessful "Rescue" incidents, or conversely Rescue incidents as successful "Fatal" incidents. Only in examining the effect of other variables can we attempt to discover the reasons for the differences in the final outcome.

CHAPTER 8

BUILDING CATEGORY & PERSONAL VARIABLES

8.0 BUILDING CATEGORY AND PERSONAL VARIABLES

In some respects, the inter-relationships between the variables considered in this chapter have a certain degree of predictability. We would not, for example, expect to find many young children in buildings other than Dwellings. Similarly, we would be unsurprised if the frequency of fire-training was lower in Dwellings than in other types of occupancies. Hypotheses concerning the effect of other Personal variables are less easy to construct. How are sex and age of those interviewed distributed across building categories? Do the cues which lead to a person first becoming aware of a fire differ between occupancies? We will attempt to provide answers to both the obvious and less obvious associations in the following sections.

8.1 BUILDING CATEGORY AND THE SEX AND AGE OF THE OCCUPANTS

It should be recognised that the 2193 people interviewed in the Present Study represent only a sample of the occupants of the buildings in which the fires occurred. Where the number of people in the building was large this sample will in fact be only a small percentage of the occupants, since the largest number of people interviewed was 12, and the average number interviewed 2.3. In examining the relationship between sex and building category, for instance, we are not therefore attempting to draw general conclusions about the occupants of buildings in terms of their sex, but merely providing a fuller description of our sample. (A critical factor of course will be the time of the incident, since occupancy of Dwellings varies both in number and sex at different times of day. We will explore this relationship further in Chapter 9.) The cross-tabulation of sex of the occupant against building category is shown in Table 32 overleaf.

Examination of Table 32 shows that the sexes are very far from evenly distributed between the building categories, and this is confirmed by χ^2 testing ($\chi^2 = 355.2$ (4 df), significant beyond the 0.001 level). Partitioning the table reveals that there are a disproportionate number of females in Dwellings and Institutions, whereas there are a disproportionate number of males in the Industrial and Office/Other categories.

TABLE 32. Sex of the occupant by building category

Sex of occupant	Building category					Total
	Dwelling	Industrial	Retail	Institution	Office/Other	
Male	477 (38.5) (41.3)	562 (45.3) (86.2)	118 (9.5) (53.6)	53 (4.3) (43.1)	30 (2.4) (69.8)	1240 (56.5)
Female	678 (71.2) (58.7)	90 (9.5) (13.8)	102 (10.7) (46.4)	70 (7.4) (56.9)	13 (1.4) (30.2)	953 (56.5)
Total	1155 (52.7)	652 (29.7)	220 (10.0)	123 (5.6)	43 (2.0)	2193 (100.0)

TABLE 33. First awareness of the fire by building category

First awareness of fire	Building category					Total
	Dwelling	Industrial	Retail	Institution	Office/Other	
Unambiguous cues	145 (41.3) (12.6)	136 (38.7) (20.9)	42 (12.0) (19.1)	15 (4.3) (12.2)	13 (3.7) (30.2)	351 (16.0)
Ambiguous cues	429 (58.4) (37.1)	172 (23.4) (26.4)	29 (10.8) (35.9)	41 (5.6) (33.3)	13 (1.8) (30.2)	734 (33.5)
Verbal cue	437 (59.5) (37.8)	177 (24.1) (27.1)	68 (9.3) (30.9)	41 (5.6) (33.3)	12 (1.6) (27.9)	835 (33.5)
Alarm cue	9 (6.9) (0.8)	100 (76.3) (15.3)	2 (1.5) (0.9)	19 (14.5) (15.4)	1 (0.8) (2.3)	131 (6.0)
Other cue	135 (55.8) (11.7)	67 (27.7) (10.3)	29 (12.0) (13.2)	1 (2.9) (5.7)	4 (1.7) (9.3)	242 (11.0)
Total	1155 (52.7)	652 (29.7)	220 (10.0)	123 (5.6)	43 (2.0)	2193 (100.0)

For the purpose of analysing the age of occupants this variable was divided into 8 categories, the first seven being 10-year steps (0-10 years, 11-20 years, etc), and the eighth containing any person over 70 years of age. The distribution of these age categories against building category is illustrated in Figures 17(a) to (e).

Inspection of Figures 17(a)-(e) shows them generally to be shaped much as we would expect. Dwellings are the only category to have a substantial number of both young and old people, although the modal age category is below both Industrial and Retail. Whilst all other building categories have an approximately normal age distribution, that for Institutions is a very uneven shape. The large percentage in the 21-30 year old age group probably represents nurses interviewed in Hospital fires.

8.2 BUILDING CATEGORY AND FIRST AWARENESS OF THE FIRE

One difficulty which arises when attempting to analyse first awareness of the fire is that the categories utilised on the questionnaire were not mutually exclusive. Thus many of those interviewed claimed to have been simultaneously aware of a number of fire manifestations. We have already seen in Section 5.3,that the most frequent cues were the perception of smoke and "being told"; however it was considered that more value would be gained by categorising these cues in a different way. This was done in the following manner:*

(a) If a person was sufficiently close to a fire to be aware of heat or flames, these cues were considered "Unambiguous".

(b) If a person became aware of the fire by seeing or smelling smoke, hearing noises or shouts, these cues were classified as "Ambiguous".

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* This method of classification may be considered open to argument. It might well be thought that seeing or smelling smoke should be classified as an "Unambiguous" cue. Earlier-cited research however (Latane and Darley, op cit) suggests that the presence of smoke may be interpreted in a number of ways not necessarily related to fire, and we have thus classified it as an "Ambiguous" cue. It could similarly be convincingly argued that "Alarm" should be classed as an "Ambiguous" cue since it is a common observation of everyday life that the sounding of a fire-alarm may well be due to a fire-drill, a system fault, a system test, an inadvertent false alarm, a malicious false alarm or several other causes, but in most people's experience it is never due to a real fire.

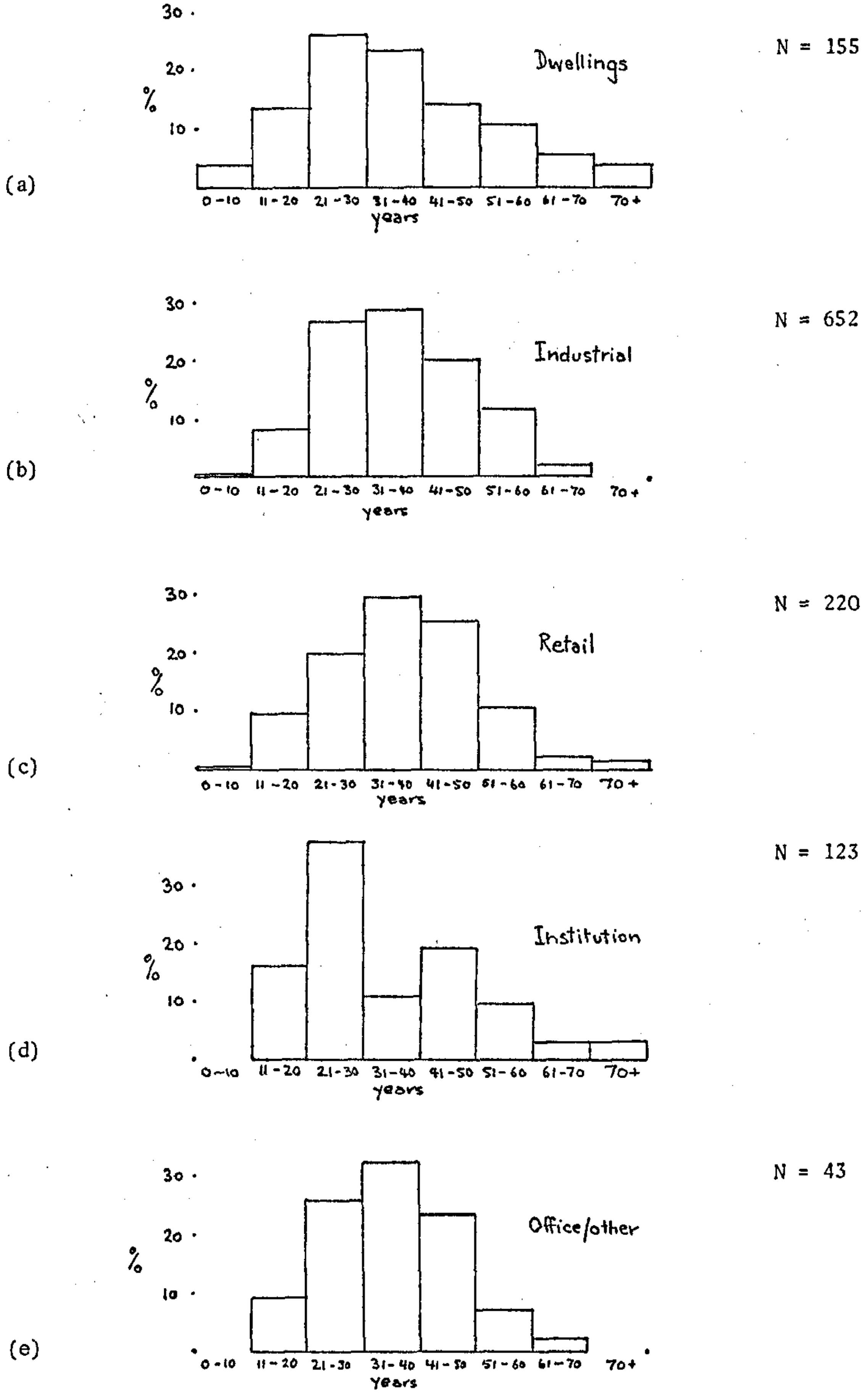

FIGURE 17. Distribution of age of occupant by category of building

(c) If a person was actually told there was a fire, this was classified as a "Verbal" cue.

(d) If a person became aware of the fire through hearing an alarm or Fire Engine, these cues were classified as "Alarm".

(e) Any other means of becoming aware of the fire were classed as "Other" cues.

The cross-tabulation of building category against how the person first became aware of the fire is shown in Table 33 (p.130).

It can be seen from Table 33 that the means by which occupants first become aware of the fire varies widely between building categories (χ^2 = 237.9 (16 df), significant beyond the 0.001 level). At least some of these differences arise from the already-discussed differences in the nature of fires in building categories (Chapter 6). Thus, for example, Dwellings tend to have high-smoke/low-Jet fires, and we would therefore expect the perception of smoke to be a common means of becoming aware of fire, accounting for the high proportion of Ambiguous cues in this building category. Since Industrial buildings have the opposite characteristics, namely low-smoke/high-Jets, there are correspondingly fewer Ambiguous cues and rather more Unambiguous ones. It is perhaps rather surprising that Alarm cues are responsible for alerting such comparatively small percentages of people in Industrial and Institution categories of building, whilst the high percentage of Verbal cues in all building categories, particularly Dwellings, emphasises the importance of communication/warning/confirmation in fires.

8.3 BUILDING CATEGORY AND PERCEPTION OF SERIOUSNESS OF THE FIRE

The interviewees ranked how serious they thought the fire was (when they realised it was a fire) on a 3-category scale. The cross-tabulation of the subjective seriousness rating between building categories is shown in Table 34 overleaf.

It can be seen from Table 34 that the occupants of buildings tend to ascribe different degrees of seriousness to fires depending upon the category of building in which they are present (χ^2 = 76.8 (8 df), significant beyond the 0.001 level). Again the occupants of Dwellings tend to stand

TABLE 34. Subjective seriousness rating of the fire by building category

Seriousness rating	Building category					Total
	Dwelling	Industrial	Retail	Institutional	Office/Other	
Not at all serious	253 (39.0) (21.8)	253 (39.0) (38.7)	83 (12.8) (37.7)	43 (6.7) (35.0)	16 (2.5) (37.2)	646 (29.5)
Quite serious	629 (57.0) (54.5)	290 (26.3) (44.7)	103 (9.3) (46.8)	65 (5.9) (52.8)	17 (1.5) (39.5)	1104 (50.3)
Extremely serious	273 (61.9) (23.6)	109 (24.7) (16.7)	34 (7.7) (15.5)	15 (3.4) (12.2)	10 (2.3) (23.3)	441 (20.1)
Total	1155 (52.7)	652 (29.7)	220 (10.0)	123 (5.6)	43 (2.0)	2193 (100.0)

TABLE 35. Familiarity with the building by building category

Familiarity with the building	Building category					Total
	Dwelling	Industrial	Retail	Institutional	Office/Other	
Completely	1044 (56.0) (90.4)	544 (29.2) (83.4)	153 (8.2) (69.5)	85 (4.6) (69.1)	37 (2.0) (86.0)	1863 (85.0)
Less than completely	111 (33.6) (9.6)	108 (32.7) (16.6)	67 (20.3) (30.5)	38 (11.5) (30.9)	6 (1.8) (14.0)	330 (15.0)
Total	1155 (52.7)	652 (29.7)	220 (10.0)	123 (5.6)	43 (2.0)	2193 (100.0)

out as a particular case (although the low percentage of extremely serious ratings in Institutions is surprising considering the potential hazard in these types of buildings, i.e. Hospitals, Geriatric Homes, Hostels, Hotels, etc). It is clear that Dwelling occupants tend to rank fires as more serious, having disproportionately small numbers in "Not at all serious", and disproportionately large numbers in "Quite" and "Extremely serious".

8.4 BUILDING CATEGORY AND FAMILIARITY OF THE OCCUPANTS WITH THE BUILDING

As was pointed out in Section 5.3, 85% of those interviewed were completely familiar with the building in which the fire occurred. This being the case, a 4-category scale of familiarity as included on the questionnaire appears redundant, and the variable was dichotomised into the following two classes:

(a) Completely familiar with the building
(b) Less than completely familiar with the building.

The cross-tabulation of this revised variable across building categories is shown in Table 35 (p.134).

Inspection of Table 35 indicates that familiarity with the building is clearly associated with the type of building ($\chi^2 = 92.9$ (4 df), significant beyond 0.001). This is hardly a surprising finding, as we would be astonished if the majority of Dwelling occupants did not claim complete familiarity with the building, (although it should be remembered that this class of building contains multi-occupancy buildings and flats, both low and high-rise, with which the occupants of any one flat may be less than familiar). Compared with Dwellings, the Industrial, Retail and Institution categories have a disproportionately large number of people who are less than completely familiar with the building, although we are to some extent surprised that these numbers are not even larger, particularly for Institutions. This perhaps reflects the relatively large number of staff who were interviewed at these incidents.

8.5 BUILDING CATEGORY AND FREQUENCY OF FIRE-TRAINING RECEIVED BY THE OCCUPANTS

As in the case of "Familiarity with the building", the majority of those interviewed (79.2%) had never received any form of fire-training, and for the same reason as applied earlier, this variable was divided into the following two classes:

(a) Never received training
(b) Received some training.

The distribution of these two categories of training frequency across building categories is shown in Table 36 overleaf.

The χ^2 value calculated from the frequencies in Table 36 is 349.2 (4df), significant beyond the 0.001 level. We may thus state with some certainty that the frequency of training of the building occupants is associated with the category of building in which the incident occurred. Again this finding is not unexpected, nor the way in which the values in the table are distributed. The large proportion of people who had received some training in Institutions adds further weight to the previous suggestion that many of those interviewed in this category were staff. Furthermore, the relatively small proportion of people who had received training in the Retail category indicates that many of these premises were small shops, rather than department stores which invariably give their staff fire-training. It seems unlikely that the alternative hypothesis, that many of those interviewed were customers, is true.

8.6 BUILDING CATEGORY AND PRESENCE OF OTHER PEOPLE IN THE BUILDING

It will be recalled from Section 5.3 that the other people present in the building were categorised under 8 headings, the first 5 of which were explicit family relationships and the last 3 being "Friends", "Acquaintances" and "People unknown to you". Whilst this detailed classification is of value when studying incidents in some depth, as in Chapters 14, 15 and 16, it was felt that quantitative analyses would be facilitated by a simpler categorisation. The relationships expressed were therefore re-classified into the following two classes:

(a) Family
(b) Not Family.

TABLE 36. Frequency of training by building category

Training frequency	Building category					Total
	Dwelling	Industrial	Retail	Institution	Office/Other	
Some training	87 (19.0) (7.5)	258 (56.5) (39.6)	38 (8.3) (17.3)	67 (14.7) (54.5)	7 (1.5) (16.3)	457 (20.8)
No training	1068 (61.5) (92.5)	394 (22.7) (60.4)	182 (10.5) (82.7)	56 (3.2) (45.5)	36 (2.1) (83.7)	1736 (79.2)
Total	1155 (52.7)	652 (29.7)	220 (10.0)	123 (5.6)	43 (2.0)	2193 (100.0)

TABLE 37. Presence of other people in the building by building category

Others present	Building category					Total
	Dwelling	Industrial	Retail	Institution	Office/Other	
Family	776 (85.7) (67.2)	24 (2.6) (3.7)	71 (7.8) (32.3)	27 (3.0) (22.0)	8 (0.9) (18.6)	1040 (47.4)
Not Family	211 (20.3) (18.3)	579 (55.7) (88.8)	135 (13.0) (61.4)	89 (8.6) (72.4)	26 (2.5) (60.5)	906 (41.3)
No others	168 (68.0) (14.5)	49 (19.8) (7.5)	14 (5.7) (6.4)	7 (2.8) (5.7)	9 (3.6) (20.9)	247 (11.3)
Total	1155 (52.7)	652 (29.7)	220 (10.0)	123 (5.6)	43 (2.0)	2193 (100.0)

There was of course a further category, that in which there was no-one else present in the building other than the interviewee, and this was named "No others". The cross-tabulation of these categories across building categories is shown in Table 37 (p.137)

Inspection of Table 37 indicates the expected discrepancy which is confirmed by χ^2 ($\chi^2 = 931.4$ (8 df), significant beyond the 0.001 level). The majority of people in Dwellings tend to be members of a family, whilst the majority of people in other types of building are not related, hardly an unanticipated finding. It is of interest, however, that some 14.5% of the Dwelling fires occurred whilst there was only a single person present in the building.

8.7 BUILDING CATEGORY AND WHETHER OCCUPANTS HAD BEEN PREVIOUSLY INVOLVED IN A FIRE INCIDENT

The cross-tabulation of previous involvement of the occupant across building categories is shown in Table 38 overleaf. Again we note that the values are very unevenly distributed between building categories, the presence of association being associated with a significant value of χ^2 ($\chi^2 = 323.7$ (4 df), significant beyond the 0.001 level).

The single most interesting result which emerges from examination of Table 38 is the startlingly high percentage of people in Industrial buildings who claim to have been previously involved in a fire.

8.8 DISCUSSION

Although the associations demonstrated in this chapter are in themselves unremarkable, they serve two main purposes. Firstly, they define our sample more closely, in terms of the buildings and their occupants, rather than considering each separately. Secondly, the relationships established here may assist in interpreting what people do in fire incidents when we come to consider Behavioural variables.

Overall perhaps the most forceful impression one gains in reviewing this chapter is the anomalous nature of the Dwelling sample in relation to the other categories. On each of the variables considered, Dwellings tend to differ. They contain a large proportion of women, the occupants

TABLE 38. Previous involvement of the occupant by building category

Previously involved	Building category					Total
	Dwelling	Industrial	Retail	Institution	Office/Other	
Yes	195 (29.9) (16.9)	368 (56.4) (56.4)	51 (7.8) (23.2)	33 (5.1) (26.8)	6 (0.9) (14.0)	653 (29.8)
No	960 (62.3) (83.1)	284 (18.4) (43.6)	169 (11.0) (76.8)	90 (5.8) (73.2)	37 (2.4) (86.0)	1540 (70.2)
Total	1155 (52.7)	652 (29.7)	220 (10.0)	123 (5.6)	43 (2.0)	2193 (100.0)

tend to become aware of the fire by Ambiguous cues, the fires tend to be considered serious, the occupants are largely completely familiar with the building and to rarely have received training, they contain family members, and the occupants are unlikely to have been previously involved in a fire. Each of the above points could have been predicted with some confidence, and it is perhaps only in comparison with other building categories that these factors appear to stand out. We should, therefore, note the peculiar nature of the Dwelling sample when considering Behavioural variables.

CHAPTER 9

FIRE VARIABLES & PERSONAL VARIABLES

9.0 FIRE VARIABLES AND PERSONAL VARIABLES

The major Fire variables with which we are concerned in this chapter are the time of the incident and its severity. As we have seen in Chapter 6, there is no single measure which accurately reflects Fire Severity, and we have therefore selected three specific aspects, namely the number of Jets used, the extent of Smoke Spread and Smoke Density. In addition to these particular measures, we will include our derived, overall measure, the level of FSI, and also explore some further aspects of incidents which involved Rescues, Injuries and Fatalities (known as RIF incidents).

We feel it would be of little value to examine the relationship between the above-mentioned measures and the full range of Personal variables. It is, for example, of small consequence to know that the use or non-use of Jets at an incident was unrelated to the sex of the building occupants. Such peripheral associations will only be explored in the context of examining a specific hypothesis, concerning more meaningful associations between variables. We have, therefore, restricted our examination of Personal variables to those which are considered to be directly related to the characteristics of the incident, namely the means by which an individual first becomes aware of the fire, how serious they consider the fire to be, and the level of fire-training of the individual.

9.1 FSI LEVEL AND SELECTED PERSONAL VARIABLES

It will be recalled that the Fire Severity Index (FSI) was derived by adding all our measures of severity in a formula which gives added weight to incidents involving Jets or Hose-reels, and those having extensive Smoke Spread. It therefore is the nearest we can approximate to an overall measure of Fire Severity. The index values were subsequently categorised into 5 levels of severity.

9.1.1 FSI LEVEL AND FREQUENCY OF TRAINING OF THE BUILDING OCCUPANTS

It is usual for people to receive fire-training in buildings which are thought to have a particular risk attached to them. This risk may simply be related to the number of people who occupy the building, or else be related to a specific hazard within the building, such as the unavoidable presence of dangerous equipment. In such buildings we may therefore have a high potential for a severe fire, which is offset perhaps by the presence of personnel who are trained to prevent it from becoming severe. These conjectures suggest opposing hypotheses of course, in the former case, that incidents involving trained people will have high levels of FSI, and in the latter that they will have low levels of FSI. The cross-tabulation of training frequency against FSI level is shown in Table 39 overleaf.

Inspection of Table 39 suggests that there is in fact very little difference in the proportions. The χ^2 calculation from the frequencies in this table gives a value of 12.4 (4 df), which is not significant at the 0.01 level. Although there is a suggestion from examining the percentages that incidents with Very Low FSI tend to have a greater proportion of trained people this discrepancy is not significant, and we must therefore conclude that there is no association between the FSI level and the frequency of training of the building occupants.

9.1.2 FSI LEVEL AND PERCEPTION OF THE SERIOUSNESS OF THE FIRE

If individuals involved in a fire make accurate judgements regarding it, we would obviously expect fires to be rated as more serious at the higher levels of FSI. The cross-tabulation of FSI level against the subjective judgement of the seriousness of the fire is shown in Table overleaf.

It is readily apparent from Table 40 that the seriousness rating and FSI level are closely associated ($\chi^2 = 262.7$ (12 df), significant beyond the 0.001 level). Whilst the relationship is imperfect, the tendency is for individuals to be relatively accurate in their judgements of the seriousness of the fire. Examination of the percentages in Table 40 suggests that they are much more likely to make valid judgements at Very Low and Very High levels of FSI, than at intermediate levels.

TABLE 39. FSI level by frequency of training

Training frequency	FSI level					Total
	Very Low	Low	Medium	High	Very High	
Some training	110 (24.1) (26.6)	152 (33.3) (20.3)	84 (18.4) (17.4)	61 (13.3) (21.3)	50 (10.9) (19.1)	457 (20.8)
No training	303 (17.5) (73.4)	597 (34.4) (79.7)	398 (22.9) (82.6)	226 (13.0) (78.7)	212 (12.2) (80.9)	1736 (79.2)
Total	413 (18.8)	749 (34.2)	482 (22.0)	287 (13.1)	262 (11.9)	2193 (100.0)

TABLE 40. FSI level by subjective seriousness rating

Seriousness rating	FSI level					Total
	Very Low	Low	Medium	High	Very High	
Not at all serious	204 (31.6) (49.4)	233 (36.1) (31.1)	118 (18.3) (24.5)	55 (8.5) (19.2)	36 (5.6) (13.7)	648 (29.5)
Quite serious	172 (15.6) (41.6)	415 (37.6) (55.4)	267 (24.2) (55.4)	146 (13.2) (50.9)	104 (9.4) (39.7)	1104 (50.3)
Extremely serious	36 (8.2) (8.7)	101 (22.9) (13.5)	97 (22.0) (20.1)	85 (19.3) (29.6)	122 (27.7) (46.6)	441 (20.1)
Total	413 (18.8)	749 (34.2)	482 (22.0)	287 (13.1)	262 (11.9)	2193 (100.0)

9.1.3 FSI LEVEL AND FIRST AWARENESS OF THE FIRE

The cross-tabulation of these variables is shown in Table 41 overleaf. With such a large table it is initially difficult to establish any specific trends; however the variables are clearly associated ($\chi^2 = 62.3$ (16 df), significant beyond the 0.001 level) for the values in the table. Some points emerge from close study of this table. For example, almost 65% of the Alarm cues and almost 60% of the Unambiguous cues occur in Very Low or Low FSI level incidents. In contrast, values in the Verbal cues category appear to be concentrated at the Medium to Very High levels of FSI. There does not appear to be a consistent trend however, and other than the points mentioned above we must simply conclude that the FSI level and "First awareness" are associated, although in a rather complex way.

9.2 USE OF JETS AND SELECTED PERSONAL VARIABLES

It has been hypothesised earlier (Chapter 6) that the use of Jets may be taken, to a certain extent, as a measure of both the intensity of the fire, in terms of heat and flames, and of Fire Spread.

9.2.1 USE OF JETS AND FREQUENCY OF TRAINING OF THE BUILDING OCCUPANTS

The cross-tabulation of these variables is shown in Table 42 below.

TABLE 42. Use of Jets by frequency of training

Training frequency	Use of Jets		Total
	Not used	Used	
No training	1150 (66.2) (80.1)	586 (33.8) (77.4)	1736 (79.2)
Some training	286 (62.6) (19.9)	171 (37.4) (22.6)	457 (20.8)
Total	1436 (65.5)	757 (34.5)	2193 (100.0)

It is clear that there is little difference between the groups, this being borne out by a χ^2 value of 1.9 (1 df) which is non-significant. We must conclude therefore that there is no association between the use or non-use of Jets at an incident and how frequently the building occupants receive training.

TABLE 41. FSI level by first awareness of the fire

First awareness of fire	FSI level					Total
	Very Low	Low	Medium	High	Very High	
Unambiguous cues	87 (24.8) (21.1)	129 (36.8) (17.2)	71 (20.2) (14.7)	24 (6.8) (8.4)	40 (11.4) (15.3)	351 (16.0)
Ambiguous cues	156 (21.3) (37.8)	253 (34.5) (33.8)	153 (20.8) (31.7)	93 (12.7) (32.4)	29 (10.8) (11.1)	734 (33.5)
Verbal cues	110 (15.0) (26.6)	238 (32.4) (31.8)	168 (22.9) (34.9)	126 (17.1) (43.9)	93 (12.7) (35.5)	735 (33.5)
Alarm cues	28 (21.4) (6.8)	57 (43.5) (7.6)	20 (15.3) (4.1)	16 (12.2) (5.6)	10 (7.6) (3.8)	131 (6.0)
Other cues	32 (13.2) (7.7)	72 (29.8) (9.6)	70 (28.9) (14.5)	28 (11.6) (9.8)	40 (16.5) (15.3)	242 (11.0)
Total	413 (18.8)	749 (34.2)	482 (22.0)	287 (13.1)	262 (11.9)	2193 (100.0)

9.2.2 USE OF JETS AND PERCEPTION OF THE SERIOUSNESS OF THE FIRE

We have already established that when Fire Severity is measured by the level of FSI, individuals tend to correctly assess how serious the fire is. We will examine if this relationship holds true when the use or non-use of Jets is the measure in Table 43 below.

TABLE 43. Use of Jets by subjective seriousness rating

Seriousness rating	Use of Jets		Total
	Not used	Used	
Not at all serious	467 (72.1) (32.5)	181 (27.9) (23.9)	648 (29.6)
Quite serious	755 (68.4) (52.6)	349 (31.6) (46.1)	1104 (50.3)
Extremely serious	214 (48.5) (14.9)	227 (51.5) (30.0)	441 (20.1)
Total	1436 (65.5)	757 (34.5)	2193 (100.0)

Inspection of the values in the table above suggests a clear association, which is confirmed as significant ($\chi^2 = 72.6$ (2 df), significant beyond the 0.001 level). Incidents in which Jets are used tend to be rated as more serious than those in which they are not used.

9.2.3 USE OF JETS AND FIRST AWARENESS OF THE FIRE

The cross-tabulation of these variables is shown in Table 44 overleaf. The χ^2 value obtained from the frequencies in this table is 20.4 (4 df), which is significant beyond the 0.001 level, thus indicating that the two variables are associated. Again, Alarm cues are more frequently associated with Low severity (i.e. non-Jet) fires. It is also interesting to note that in non-Jet fires, Ambiguous cues are the modal category, whereas in Jet fires Verbal cues are the most frequent.

TABLE 44. First awareness of fire by use of Jets

Use of Jets	First awareness of fire					Total
	Unambiguous cues	Ambiguous cues	Verbal cues	Alarm cues	Other cues	
No Jets	243 (16.9) (69.2)	517 (36.0) (70.4)	444 (30.9) (60.4)	80 (5.6) (61.1)	152 (10.6) (62.8)	1436 (65.5)
Jets used	108 (14.3) (30.8)	217 (28.7) (29.6)	291 (38.4) (39.6)	51 (6.7) (38.9)	90 (11.9) (37.2)	757 (34.5)
Total	351 (16.0)	734 (33.5)	735 (33.5)	131 (6.0)	242 (11.0)	2193 (100.0)

9.3 EXTENT OF SMOKE SPREAD AND SELECTED PERSONAL VARIABLES[*]

Since extensive Smoke Spread is closely associated with Dwellings, we would, if there was simple transitivity between variables, expect those Personal variables which are also associated with Dwellings to be related. These simple relationships, however, do not necessarily follow.

9.3.1 EXTENT OF SMOKE SPREAD AND FREQUENCY OF TRAINING OF THE BUILDING OCCUPANTS

The cross-tabulation of these variables is presented in Table 45 overleaf. Examination of this table reveals that there is a virtually consistent trend in the proportions, the number of people with no training increasing as smoke spreads more extensively. The relationship is statistically significant ($\chi^2 = 34.3$ (4 df), which is significant beyond the 0.001 level). Increasing levels of Smoke Spread are clearly associated with a decreasing proportion of people who have received fire-training.

9.3.2 EXTENT OF SMOKE SPREAD AND PERCEPTION OF THE SERIOUSNESS OF THE FIRE

Intuitively it would be predicted that these two variables would be very closely associated. The cross-tabulation of them is presented in Table 46 overleaf. It can be seen from this table that there is a close, but imperfect correlation between the increasing perception of the fire's seriousness and the increasing level of Smoke Spread ($\chi^2 = 183.9$ (8 df), significant beyond the 0.001 level).

9.4 DENSITY OF SMOKE AND SELECTED PERSONAL VARIABLES

Earlier analyses suggest that Smoke Spread and Smoke Density act in a similar fashion as measures of Fire Severity.

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[*] For both Smoke Spread and Smoke Density we have omitted the cross-tabulation with "First awareness of the fire". It would be merely re-stating the obvious to suggest that in incidents with dense or extensive Smoke Spread, building occupants tended to become first aware of the fire by Ambiguous(i.e. smoke) cues.

TABLE 45. Smoke Spread by frequency of training

Training frequency	Extent of Smoke Spread					Total
	Little or none	Room of origin	Floor of origin	Floor above	More extensive	
Some training	78 (17.0) (30.3)	171 (37.4) (24.8)	105 (23.0) (17.0)	69 (15.5) (15.5)	34 (7.4) (18.6)	457 (20.8)
No training	179 (10.3) (69.7)	519 (29.9) (75.2)	513 (29.6) (83.0)	376 (21.7) (84.5)	149 (8.6) (81.4)	1736 (79.2)
Total	257 (11.7)	690 (31.5)	618 (28.2)	445 (20.3)	183 (8.3)	2193 (100.0)

TABLE 46. Extent of Smoke Spread by subjective seriousness rating

Seriousness rating	Extent of Smoke Spread					Total
	Little or none	Room of origin	Floor of origin	Floor above	More extensive	
Not at all serious	132 (20.3) (51.4)	240 (37.0) (34.8)	143 (22.1) (23.1)	103 (15.9) (23.1)	30 (4.6) (16.4)	648 (29.6)
Quite serious	102 (9.2) (59.7)	351 (31.8) (50.9)	355 (32.2) (57.4)	226 (20.5) (50.8)	70 (6.3) (38.3)	1104 (50.3)
Extremely serious	23 (5.2) (8.9)	99 (22.4) (14.3)	120 (27.2) (19.4)	116 (26.3) (26.1)	83 (18.8) (45.4)	441 (20.1)
Total	257	690	618	445	183	2193 (100.0)

9.4.1 DENSITY OF SMOKE AND FREQUENCY OF TRAINING OF THE BUILDING OCCUPANTS

The cross-tabulation of these variables is shown in Table 47 overleaf. As with Smoke Spread, we have a close but not completely consistent relationship, the proportion of people with "No training" tending to increase with increasing Smoke Density ($\chi^2 = 32.0$ (6 df), which is significant beyond the 0.001 level).

9.4.2 DENSITY OF SMOKE AND PERCEPTION OF THE SERIOUSNESS OF THE FIRE

We would expect a similar result for these variables as with that for Smoke Spread. The cross-tabulation is presented in Table 48 overleaf. As was predicted, the resulting association in Table 48 closely matches that already demonstrated with Smoke Spread ($\chi^2 = 217.8$ (12 df), which is significant beyond the 0.001 level). Thus, as Smoke Density increases, so do peoples' perceptions of the seriousness of the fire, although this association is not completely consistent.

9.5 TIME OF THE INCIDENT AND SELECTED PERSONAL VARIABLES

As in earlier analyses in which we considered the effect of time, we have reclassified this into "Day" (0600 to 2159) and "Night" (2200 to 0559). The only two Personal variables which are of interest are "First awareness of the fire" and "Subjective seriousness".

9.5.1 TIME OF THE INCIDENT AND FIRST AWARENESS OF THE FIRE

The cross-tabulation of the time of the incident against first awareness of the fire is shown in Table 49 (p.153). We would perhaps have tentatively hypothesised that Ambiguous cues were more likely in night-time incidents; however inspection of this table shows that whilst the expected frequency is lower than the observed frequency, there is not a large difference. The largest single discrepancy is, of course, the uneven distribution in the Alarm category, which we might also have predicted since this will be associated with "work" environments, incidents which tend to happen in the daytime. This accounts for the largest part of the significant differences in Table 49 ($\chi^2 = 14.1$ (4 df), which is significant beyond the 0.01 level).

TABLE 47. Smoke Density by frequency of training

Training frequency	Smoke Density scale-values							Total
	1	2	3	4	5	6	7	
Some training	178 (38.9) (27.1)	74 (16.2) (23.6)	73 (16.0) (16.9)	58 (12.7) (16.3)	38 (8.3) (15.4)	18 (8.9) (15.9)	18 (3.9) (23.7)	457 (20.8)
No training	478 (27.5) (72.9)	240 (13.8) (76.4)	359 (20.7) (83.1)	298 (17.2) (83.7)	208 (12.0) (84.6)	95 (5.5) (84.1)	58 (3.3) (76.3)	1736 (79.2)
Total	656 (29.9)	314 (14.3)	432 (19.7)	356 (16.2)	246 (11.2)	113 (5.2)	76 (3.5)	2193 (100.0)

TABLE 48. Smoke Density by subjective seriousness rating

Seriousness rating	Smoke Density scale-values							Total
	1	2	3	4	5	6	7	
Not at all serious	314 (48.5) (47.9)	79 (12.2) (25.2)	97 (15.0) (22.5)	84 (13.0) (23.6)	45 (6.9) (18.3)	15 (2.3) (13.3)	14 (2.2) (18.4)	648 (29.5)
Quite serious	283 (25.6) (43.1)	190 (17.2) (60.5)	235 (21.3 (54.4)	179 (16.2) (50.3)	123 (11.1) (50.0)	58 (5.3) (51.3)	36 (3.3) (47.4)	1104 (50.3)
Extremely serious	59 (13.4) (13.4)	45 (10.2) (14.3)	100 (22.7) (23.1)	93 (21.1) (26.1)	78 (17.7) (31.7)	40 (9.1) (35.4)	26 (5.9) (34.2)	441 (20.1)
Total	656 (29.9)	314 (14.3)	432 (19.7)	356 (16.2)	246 (11.2)	113 (5.2)	76 (3.5)	2193 (100.0)

TABLE 49. First awareness of fire by time of the incident

Time	First awareness of fire					Total
	Unambiguous cues	Ambiguous cues	Verbal cues	Alarm cues	Other cues	
Day	292 (16.5) (83.2)	584 (33.0) (79.6)	587 (33.2) (79.9)	120 (6.8) (91.6)	187 (10.6) (77.3)	1770 (80.7)
Night	59 (13.9) (16.8)	150 (35.5) (20.4)	148 (35.0) (20.1)	11 (2.6) (8.4)	55 (13.0) (22.7)	423 (19.3)
Total	351 (16.0)	734 (33.5)	735 (33.5)	131 (6.0)	242 (11.0)	2193 (100.0)

9.5.2 TIME OF THE INCIDENT AND PERCEPTION OF THE SERIOUSNESS OF THE FIRE

Intuitively, we would suppose that incidents which occur at night-time would be perceived as more serious than those which occur in the daytime, as in fact we have shown they are on all our measures of Fire Severity (see Sections 9.1.2, 9.2.2, 9.3.2, 9.4.2). The cross-tabulation of time against seriousness is shown in Table 50 below.

TABLE 50. Subjective seriousness rating by time of the incident

Time	Seriousness rating			Total
	Not at all serious	Quite serious	Extremely serious	
Day	527 (29.8) (81.3)	908 (51.3) (82.2)	335 (18.9) (76.0)	1770 (80.7)
Night	121 (28.6) (18.7)	196 (46.3) (17.8)	103 (25.1) (24.0)	423 (19.3)
Total	648 (29.5)	1104 (50.3)	441 (20.1)	2193 (100.0)

It can be seen from Table 50 that night-time incidents do appear to be perceived as being more serious, although the differences are not large. In fact, χ^2 calculated from the values above gives a value of 8.2 (2 df), which fails to reach our pre-set rejection level of 0.01. We must therefore conclude that there is not significant association between night-time and daytime incidents in terms of their subjective seriousness.

9.6 OCCURRENCE OF RESCUE, INJURY AND FATAL (RIF) INCIDENTS AND PERSONAL VARIABLES

We have previously explored the effect of Building and Fire variables upon RIF incidents in Chapter 7. In this section we will concern ourselves with the effect of relevant Personal variables. It is probably worth reiterating that, with only a few exceptions, information collected from RIF incidents relates to building occupants who were not the victim. We have merely chosen to treat these incidents as a separate category on the basis that they represent an unsuccessful response to fires. It is of interest, therefore, to establish whether the level of training, familiarity, previous involvement and seriousness rating of people in such incidents differs from that of people involved in Non-RIF incidents.

As has already been pointed out, Rescue, Injuries and Fatalities are not independent categories. We cannot therefore test our variables against the whole RIF group, but must treat each category separately. Before moving on to construct contingency tables for each class, we will first present a frequency table for the two groups, Non-RIF and RIF incidents.

TABLE 51. Number of people in Non-RIF and RIF incidents

	Non-RIF incidents	RIF incidents		
		Rescues	Injuries	Fatalities
Number of people involved	2019	50	146	17

9.6.1 RIF INCIDENTS AND FREQUENCY OF TRAINING

The contingency tables and χ^2 values for Rescues, Injuries and Fatalities are shown below.

Rescues	Training frequency		Total
	None	Some	
No Rescues	1691	452	2143
Rescues	45	5	50
Total	1736	457	2193

χ^2 = 3.64 (1 df), non-significant

Injuries	Training frequency		Total
	None	Some	
No Injuries	1612	435	2047
Injuries	124	22	146
Total	1736	457	2193

χ^2 = 3.15 (1 df), non-significant

Fatalities	Training frequency		Total
	None	Some	
No Fatalities	1725	451	2176
Fatalities	11	6	17
Total	1736	457	2193

$\chi^2 = 2.17$ (1 df), non-significant

We can therefore see from the evidence of the above three tables that there is no significant difference between Non-RIF and RIF incidents in terms of the frequency of training of the building occupants.

9.6.2 RIF INCIDENTS AND FAMILIARITY WITH THE BUILDING

The contingency tables and χ^2 values for Rescues, Injuries and Fatalities are shown below.

Rescues	Familiarity with building		Total
	Completely	Less than completely	
No Rescues	1832	311	2143
Rescues	31	19	50
Total	1863	330	2193

$\chi^2 = 21.0$ (1 df), significant beyond 0.001

Injuries	Familiarity with building		Total
	Completely	Less than completely	
No Injuries	1754	293	2047
Injuries	109	37	146
Total	1863	330	2193

$\chi^2 = 12.9$ (1 df), significant beyond 0.001

Fatalities	Familiarity with building		Total
	Completely	Less than completely	
No Fatalities	1849	327	2176
Fatalities	14	3	17
Total	1863	330	2193

χ^2 = 0.9 (1 df), non-significant

There is a clear association between "Familiarity with the building" and the occurrence of Rescues and Injuries. In both cases, the occupants are more likely to be "Less than completely familiar with the building". This is not the case for incidents involving Fatalities, in which there is no association between "Familiarity with the building" and their occurrence.

9.6.3 RIF INCIDENTS AND PREVIOUS INVOLVEMENT IN A FIRE INCIDENT

The contingency tables and χ^2 values for Rescues, Injuries and Fatalities are shown below.

Rescues	Previous involvement		Total
	No	Yes	
No Rescues	1496	647	2143
Rescues	44	6	50
Total	1540	653	2193

χ^2 = 7.7 (1 df), significant beyond 0.01

Injuries	Previous involvement		Total
	No	Yes	
No Injuries	1411	636	2047
Injuries	129	17	146
Total	1540	653	2193

χ^2 = 24.5 (1 df), significant beyond 0.001

Fatalities	Previous involvement		Total
	No	Yes	
No Fatalities	1527	649	2176
Fatalities	13	4	17
Total	1540	653	2193

χ^2 = 0.3 (1 df), non-significant

Yet again, it is the Fatal incidents in which there is no association between the Personal variable and their occurrence. In contrast, for buildings in which either Rescues or Injuries occur, the occupants are significantly less likely to have been previously involved in a fire incident.

9.6.4 RIF INCIDENTS AND SUBJECTIVE SERIOUSNESS RATING OF THE FIRE

The contingency tables and χ^2 values for Rescues, Injuries and Fatalities are shown below.

Rescues	Seriousness rating			Total
	Not at all serious	Quite serious	Extremely serious	
No Rescues	641	1085	417	2143
Rescues	7	19	24	50
Total	648	1104	441	2193

χ^2 = 25.5 (2 df), significant beyond 0.001

Injuries	Seriousness rating			Total
	Not at all serious	Quite serious	Extremely serious	
No Injuries	616	1043	388	2047
Injuries	32	61	53	146
Total	648	1104	441	2193

χ^2 = 25.7 (2 df), significant beyond 0.001

Fatalities	Seriousness rating			Total
	Not at all serious	Quite serious	Extremely serious	
No Fatalities	646	1098	432	2176
Fatalities	2	6	9	17
Total	648	1104	441	2193

$\chi^2 = 11.7$ (2 df), significant beyond 0.01

In this case we can see that each of the three categories of RIF incident is associated with high seriousness rating. We may thus state that for incidents in which Rescues, Injuries or Fatalities occur, the occupants of the building are significantly more likely to perceive the incident as being serious.

9.7 DISCUSSION

It is plain from the evidence of this chapter that our selected Personal variables do not inevitably act in the way in which we would have intuitively predicted. The frequency of training, for example, which might be considered to have powerful effects, is associated only with smoke characteristics, of the variables considered here. In this case the correlation is between increasing values of Smoke Spread and Smoke Density, and decreasing proportions of people who have received training. Since we have already seen that Dwellings are associated individually with high levels of smoke and low levels of training, this finding may simply be a significant interaction of these two effects, an aspect we will explore in Chapter 13.

With reference to the means by which individuals first become aware of the fire, it is difficult to draw any clear conclusions. It is possible that our reclassification, although necessary, may have disguised some important connection, however this seems unlikely. One aspect which is of some interest is the implication that Low FSI fires are associated with Unambiguous cues. This seems inherently plausible, in the sense that if a person becomes first aware of a fire by seeing flames or feeling heat, it is likely that the fire is in an early stage of development. In this event, the time available to take preventative action is correspondingly greater, which may preclude the fire from becoming more severe.

Perhaps the single most interesting finding is the relatively close association between subjective judgements of the fire's seriousness, and our objective measure of Fire Severity. Further evidence is provided by a study of the Spearman correlation coefficients calculated for these scales. They are shown in Table 52 below.

TABLE 52. Spearman correlation coefficient values for subjective seriousness by FSI, Smoke Density, Smoke Spread and the number of Jets.

		Fire Severity measures			
		FSI	Smoke Density	Smoke Spread	Number of Jets
Subjective seriousness	rs.	0.306	0.288	0.248	0.173
	signif.	0.001	0.001	0.001	0.001

It can be seen that positive and significant correlations are obtained in each case, although the relatively low values indicate that the associations are imperfect.

Attempting to study RIF incidents by analysing the attributes of the other people in the incident may appear a rather circuitous procedure; however in the absence of evidence from those directly affected, it is the only course available. Irrespective of this constraint, we feel that it is in itself a valid procedure if we assume, as we must, that the characteristics and behaviour of all those involved in RIF incidents may have had a bearing upon the eventual outcome.

Regarding these incidents, it is surprising to find that, again, the frequency of training is unrelated to their occurrence. Furthermore, although we find a disproportionately large number of people who have not had previous experience of fire, and a disproportionately large number who are unfamiliar with the layout of the building in both Rescue and Injury incidents, these associations are not manifest in Fatal incidents, a finding we would not have anticipated, and one which is resistant to explanation. For seriousness, individuals in all categories of RIF incident tend to rate them towards the higher end of the subjective seriousness scale, which again correlates well with the objective Fire Severity measures attached to this type of incident.

CHAPTER 10

BUILDING VARIABLES AND BEHAVIOUR

10.0 BUILDING VARIABLES AND BEHAVIOUR

As was outlined in Chapter 5, the behaviour of people in the incidents studied was examined in two ways. Firstly, by a broad, unstructured enquiry into the actions which they undertook when they realised there was a fire, and secondly, by an examination of three specific aspects: whether people left the building during the course of the fire, whether they returned into the building, and whether they moved through smoke.

In our original classification of general behaviour, actions were broken down into 29 separate categories. As was discussed earlier, the distinction between several of these categories is rather subtle, and it would appear that little information is lost if categories which have the same implicit meaning, or express similar intention are combined. After careful study of our multiple classification, it was found possible to reduce the 29 discrete actions to 12 broader groups. The precise manner in which this reclassification was undertaken is illustrated in Appendix 8, (p.339). The 12 revised types of behaviour are shown below.

1. Investigate
2. Contact Fire Brigade
3. Alert others
4. Evacuate self
5. Evacuate others
6. Fire-fighting
7. Minimise risk
8. Increase risk
9. Request assistance
10. Render assistance
11. Retreat from fire
12. Something else

These reclassified actions will be utilised in all subsequent discussions of general behaviour, unless otherwise specified.

Whilst in Chapter 5 we briefly discussed first, second and third actions separately, this is clearly of only limited value, and in examining the effect of other variables upon general behaviour we will adopt a more meaningful type of analysis. In this we have not cross-tabulated each action by another variable (which in any case would be extremely unwieldy and difficult to interpret), but instead we have analysed the data so as to uncover "sequences of actions". Utilising this form of analysis we can examine the occurrence of certain patterns of behaviour across each of our chosen independent variables.

Before moving on to consider the analyses, we will first illustrate how the data will be presented. For convenience, the behaviour patterns are set out under the headings of First, Second and Third Actions. So, for example, in Dwellings we find the following series of action sequences occur:

	First Action	%		Second Action	%		Third Action	%
(a)	Fire-fight	(10.2)	→	Contact FB	(31.3)	<	Minimise risk	(18.9)
							Maximise risk	(16.2)

This means that 10.2% of the occupants of Dwellings undertook fire-fighting as a First Action. Of this 10.2%, 31.3% then contacted the Fire Brigade, and of this group, 18.9% did something to minimise the risk, and 16.2% did something to maximise the risk.

In some cases, individuals only undertook one basic course of action throughout the incident, and this will be presented as below:

	First Action	%		Second Action	%		Third Action	%
(a)	Request assistance	(2.8)	→	——		→	——	(95.2)

In each case, sequences of action will be presented in descending order of frequency of First Action, and only those actions which were undertaken by at least 5% of the group will be illustrated.

10.1 BEHAVIOUR IN RELATION TO BUILDING CATEGORY

For each variable we will consider four aspects of behaviour, namely sequences of action, evacuation of the building, re-entry into the building and movement through smoke.

10.1.1 SEQUENCES OF ACTION IN RELATION TO BUILDING CATEGORY

The most frequent action sequences undertaken by the 1155 occupants of Dwellings who were interviewed are presented below:

	First Action	%		Second Action	%		Third Action	%
(a)	Investigate	(18.1)	<	Contact FB	(19.6)	→	——	(39.0)
				Minimise risk	(16.7)	→	Contact FB	(34.3)
				Fire-fight	(15.3)	→	——	(43.8)

First Action	%	Second Action	%	Third Action	%
(b) Contact FB	(13.2)	Fire-fight	(16.4)	——	(64.0)
		Minimise risk	(15.1)	——	(50.0)
		Evacuate self	(10.5)	——	(86.7)
(c) Minimise risk	(11.3)	Contact FB	(35.1)	Fire-fight	(16.2)
				Minimise risk	(16.2)
				Increase risk	(16.2)
		Alert others	(13.0)	Contact FB	(41.2)
(d) Evacuate others	(11.2)	Contact FB	(25.6)	Fire-fight	(30.3)
		Minimise risk	(16.3)	Contact FB	(47.6)
		Evacuate self	(10.9)	——	(64.3)
(e) Alert others	(10.7)	Evacuate self	(17.7)	——	(63.6)
(f) Fire-fight	(10.2)	Contact FB	(34.7)	——	(32.4)
		Evacuate others	(9.7)	Contact FB	(54.5)
		Minimise risk	(9.7)	Contact FB	(60.0)
(g) Evacuate self	(9.5)	——		——	(54.5)
		Contact FB	(18.2)	——	(55.0)

Examination of the above action sequences in Dwellings shows that the range is quite diverse, only a relatively small number choosing to undertake each particular course of behaviour. One recurrent theme is the way in which the Fire Brigade is often contacted as a Second or Third Action, as is the action of minimising risk, which in Dwellings was often either shutting doors or switching-off electric or gas mains.

The most frequent action sequences undertaken by the 652 occupants of Industrial category buildings who were interviewed are presented below:

First Action	%	Second Action	%	Third Action	%
(a) Fire-fight	(22.1)	——		——	(38.1)
		Contact FB	(13.2)	——	(31.6)
		Evacuate self	(10.4)	——	(60.0)
(b) Investigate	(19.2)	Fire-fight	(47.2)	——	(69.5)
(c) Alert others	(19.0)	Fire-fight	(49.1)	——	(70.2)
(d) Contact FB	(10.6)	Fire-fight	(30.4)	——	(61.9)
		Investigate	(21.7)	Fire-fight	(40.0)
(e) Evacuate self	(9.8)	——		——	(73.4)
(f) Minimise risk	(9.0)	Fire-fight	(30.5)	——	(77.8)

It is obvious that in Industrial buildings the range of action sequences is much less wide, and the popularity of fire-fighting as a course of action is noticeable. Not only is it the most frequent First Action, but it also tends to dominate the Second and Third Actions.

The most frequent action sequences undertaken by the 220 occupants of Retail category buildings who were interviewed are presented below:

	First Action	%	Second Action	%	Third Action	%
(a)	Contact FB	(20.0) →	Fire-fight	(29.5) →	——	(76.9)
(b)	Fire-fight	(19.5) →	Contact FB	(62.8) →	——	(40.0)
(c)	Investigate	(11.4) →	Fire-fight	(24.0) →	——	(25.0)
(d)	Minimise risk	(10.9) →	Fire-fight	(33.3) →	Contact FB	(62.5)
(e)	Alert others	(10.0) <	Contact FB	(31.8) →	——	(28.6)
			Evacuate self	(18.2) →	——	(75.0)

In Retail category buildings the actions which predominate are fire-fighting and contacting the Fire Brigade, nearly 40% of those interviewed undertaking these actions either in one order or the other.

The most frequent action sequences undertaken by the 123 occupants of Institution category buildings who were interviewed are presented below:

	First Action	%	Second Action	%	Third Action	%
(a)	Alert others	(17.1) →	Investigate	(23.8) →	——	(20.0)
(b)	Fire-fight	(11.4) →	Contact FB	(35.7) →	——	(40.0)

It is interesting that in the case of Institution buildings, a relatively large percentage of people warn other occupants before they investigate, a course of action which will obviously aid any subsequent evacuation. The fact that warning others is the most popular First Action, whereas in other occupancies it is often the third, fourth or fifth most popular, may also be considered significant.

The most frequent action sequences by the 43 occupants of the Office/Other category buildings who were interviewed are presented below:

	First Action	%	Second Action	%	Third Action	%
(a)	Contact FB	(25.6) →	Fire-fight	(27.2) →	——	(66.6)
(b)	Fire-fight	(20.9) →	——	→	——	(22.2)

With such small frequencies, we cannot reach any firm conclusions; however it is plain that fire-fighting and contacting the Fire Brigade predominate in the Office/Other category when a fire incident occurs.

10.1.2 EVACUATION IN RELATION TO BUILDING CATEGORY

Unlike our other behavioural variables, evacuation of the building* can be examined in two alternative ways. Firstly, each of the 2193 occupants who were interviewed were asked if they left the building during the fire. Secondly, the Fire Brigade officers who attended the incident were asked to record the number of people who left the building during the course of the fire, and also the number of people who were in the building when the fire was discovered. Where there were large numbers of occupants, the officer could obviously not be expected to make an exact count, and an estimate was considered acceptable. From this latter method it is therefore possible to calculate the proportion of occupants who left the building in each of the 952 incidents.

We will first examine our sample of respondants, and the cross-tabulation of building category against whether an individual left the building during the course of the fire is shown in Table 53 overleaf. Study of this table shows there are conspicuous differences in the proportion of individuals leaving different categories of building. This is verified by the χ^2 value of 110.0 (4 df), which is significant beyond the 0.001 level. It is clear that the largest component of this number is the difference between Dwellings and other categories, and we may thus state that the occupants of Dwellings are significantly more likely to leave the building than the occupants of other building types.

It is convenient to divide the proportion of people who left the building into 5 categories. This has therefore been done in Table overleaf which shows the proportion leaving in different categories of building. Again we can see that Dwellings tend to differ from other types of building, having a substantially smaller percentage of incidents in which no-one left the building, and a substantially larger percentage of incidents in which everyone left. The differences within Table 54 are statistically significant ($\chi^2 \doteq 64.6$ (16 df), significant beyond the 0.001 level). It is also of note that nearly 80% of the incidents overall are accounted for by the two categories, 0% and 100%.

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* In common usage, the term "evacuation" is usually applied to a more-or-less orderly leaving of the building by its occupants. In this and subsequent chapters, the term is used in the rather more general sense to simply mean "leaving the building". No connotation of pre-planning or orderliness is implied.

TABLE 53. Building category by evacuation behaviour

Leave the building	Building category					Total
	Dwelling	Industrial	Retail	Institution	Office/Other	
Not leave	412 (41.0) (35.7)	393 (39.1) (60.3)	113 (11.2) (51.4)	68 (6.8) (55.4)	19 (1.9) (44.2)	1005 (45.8)
Leave	743 (62.5) (64.3)	259 (21.8) (39.7)	107 (9.0) (48.6)	55 (4.6) (44.6)	24 (2.0) (55.8)	1188 (54.2)
Total	1155 (52.7)	652 (29.7)	220 (10.0)	123 (5.6)	43 (2.0)	2193 (100.0)

TABLE 54. Building category by proportion of people leaving the building

Proportion leaving each incident	Building cateogry					Total
	Dwelling	Industrial	Retail	Institution	Office/Other	
0%	147 (49.8) (24.6)	80 (27.1) (40.8)	41 (13.9) (42.3)	16 (5.4) (41.0)	11 (3.7) (50.0)	295 (31.0)
1% to 30%	33 (57.9) (5.5)	16 (28.1) (8.2)	1 (1.8) (1.0)	5 (8.8) (12.8)	2 (3.5) (9.1)	57 (6.0)
31% to 70%	63 (67.0) (10.5)	22 (23.4) (11.2)	9 (9.6) (9.3)	0 (0.0) (0.0)	0 (0.0) (0.0)	94 (9.9)
71% to 99%	19 (45.2) (3.2)	14 (33.3) (7.1)	7 (16.7) (7.2)	1 (2.4) (2.6)	1 (2.4) (4.5)	42 (4.4)
100%	336 (72.4) (56.2)	64 (13.8) (32.7)	39 (8.4) (40.2)	17 (3.7) (43.6)	8 (1.7) (36.4)	464 (48.7)
Total	598 (62.8)	196 (20.6)	97 (10.2)	39 (4.1)	22 (2.3)	952 (100.0)

We cannot know how Table 53 relates to Table 54, in the sense that if an individual stated that they did not leave the building we only know they cannot have been in the 48.7% of incidents in which everyone left. Similarly if they said they did leave, they could be in any category except the 31.0% of incidents in which no-one left. We can, however, attempt to estimate how the Tables relate to one another using Dwellings as an example.

Thus referring to Table 53, we know that 412 people stated they did not leave Dwellings during the course of the fire. These 412 persons must have come from the 147 Dwelling incidents in which no-one left, plus some proportion of the Dwelling incidents in which less than 100% of the people left. Let us assume that half of the incidents in the categories 1% to 99% (Table 54) contributed interviewees. We can then calculate the average number of people per incident who did not leave the building and were interviewed. We can perform a similar calculation for those who stated they left Dwellings, knowing that the 743 people who stated they left must have come from the 336 incidents in which everyone left, again assuming that half the incidents in categories 1% to 99% contributed interviewees. The calculations for Dwellings are shown below.

(a) Number of interviewees who did not leave = 412
Number of incidents in which no-one left = 147
Number of incidents in categories 1% to 99% = 115
Average number of people interviewed per incident who did not leave

$$= 412/(147 + [115/2]) = \frac{412}{205} = 2.0 \text{ people/incident}$$

(b) Number of interviewees who did leave = 743
Number of incidents in which everyone left = 336
Number of incidents in categories 1% to 99% = 115
Average number of people interviewed per incident who did leave

$$= 743/(336 + [115/2]) \div \frac{743}{394} = 1.9 \text{ people/incident}$$

On this basis therefore, it would seem that approximately equal numbers of people were interviewed in both the leave, and not leave categories.

10.1.3 RETURNING INTO THE BUILDING IN RELATION TO BUILDING CATEGORY

Those interviewed were asked if they returned into the building during the course of the fire. The cross-tabulation of their responses against building category is shown in Table 55 overleaf. It can be seen that the proportions are remarkably homogeneous, the absence of association being confirmed by the χ^2 test ($\chi^2 = 2.1$ (4 df), non-significant). We can thus state that whether or not an individual returned into the building was independent of the building category.

10.1.4 MOVEMENT THROUGH SMOKE IN RELATION TO BUILDING CATEGORY

We have already seen in Chapter 6 that Dwelling fires tend to be characterised by extensive and dense smoke. We would therefore expect a greater proportion of the occupants to move through it. The cross-tabulation of whether or not an individual moved through smoke* in different building categories is shown in Table 56 overleaf. It is clear that, as predicted, Dwellings have the highest proportion of individuals moving through smoke; however this value is not substantially different from that in other categories except Industrial ($\chi^2 = 22.2$ (4 df), significant beyond the 0.001 level) where the largest component of the statistic is accounted for by the disproportionately low number moving through smoke in this category.

10.2 BEHAVIOUR IN RELATION TO NUMBER OF BUILDING OCCUPANTS

As in earlier analyses, we are interested in examining the effect of large numbers of occupants upon the variables. We have subsequently divided our sample into two categories, incidents involving buildings with less than 100 occupants and incidents involving buildings containing more than 100 occupants.

10.2.1 SEQUENCES OF ACTION IN RELATION TO NUMBER OF BUILDING OCCUPANTS

The most frequent action sequences undertaken by the 1979 occupants of buildings with less than 100 people are presented below.

First Action	%	Second Action	%	Third Action	%
(a) Investigate	(17.0)	Fire-fight	(22.9)	——	(57.1)
				Contact FB	(14.3)
		Contact FB	(16.4)	——	(29.1)
				Fire-fight	(16.4)
				Minimise risk	(14.5)
		Minimise risk	(14.0)	Contact FB	(25.5)
				Fire-fight	(21.3)

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* In all tabulations of movement through smoke, only those incidents at which smoke was present are included. Thus, the category "Not move" means there was smoke which the individual did not attempt to move through, not that there was no smoke.

TABLE 55. Building category by returning into the building

Return into building	Building category					Total
	Dwelling	Industrial	Retail	Institution	Office/Other	
Not return in	412 (62.0) (55.5)	153 (23.0) (59.0)	56 (8.4) (52.3)	32 (4.8) (58.2)	12 (1.8) (50.0)	665 (56.0)
Return in	331 (63.3) (44.5)	106 (20.3) (41.0)	51 (9.8) (47.7)	23 (4.4) (41.8)	12 (2.3) (50.0)	523 (44.0)
Total	743 (62.5)	259 (21.8)	107 (9.0)	55 (4.6)	24 (2.0)	1188 (100.0)

TABLE 56. Building category by movement through smoke

Movement through smoke	Building category					Total
	Dwelling	Industrial	Retail	Institution	Office/Other	
Not move	388 (50.5) (36.5)	252 (32.8) (48.8)	77 (10.0) (38.9)	37 (4.8) (40.7)	15 (2.0) (42.9)	769 (40.4)
Move	675 (59.5) (63.5)	264 (23.3) (51.2)	121 (10.7) (61.1)	54 (4.8) (59.3)	20 (1.8) (57.1)	1134 (59.6)
Total	1063 (55.8)	516 (27.1)	198 (10.4)	91 (4.8)	35 (1.8)	1903 (100.0)

	First Action		Second Action		Third Action	
(b)	Fire-fight	(15.1)	—		—	(30.4)
			Contact FB	(25.4)	—	(31.5)
					Fire-fight	(19.7)
					Minimise risk	(19.7)
(c)	Contact FB	(13.6)	Fire-fight	(22.6)	—	(65.6)
			Evacuate self	(9.6)	—	(80.8)
(d)	Alert others	(12.8)	Fire-fight	(20.4)	—	(61.5)
(e)	Minimise risk	(10.4)	Contact FB	(21.5)	Firefight	(27.2)
			Fire-fight	(16.6)	-	(41.1)
					Contact FB	(38.2)
(f)	Evacuate self	(9.7)	—		—	(54.7)
			Contact FB	(14.5)	—	(53.6)
(g)	Evacuate others	(7.4)	Contact FB	(24.5)	—	(27.8)
					Fire-fight	(27.8)

Similarly, the most frequent action sequences undertaken by the 214 occupants of buildings with more than 100 people are presented below for comparison.

	First Action	%	Second Action	%	Third Action	%
(a)	Investigate	(25.7)	Fire-fight	(38.2)	—	(58.3)
(b)	Fire-fight	(13.6)	—		—	(41.3)
(c)	Alert others	(13.1)	Investigate	(28.6)	—	(24.2)
			Fire-fight	(35.7)	—	(21.9)
(d)	Evacuate self	(8.9)	—		—	(63.2)
(e)	Minimise risk	(8.4)	—		—	(25.4)
(f)	Contact FB	(7.0)	Investigate	(33.3)	Fire-fight	(60.0)
(g)	Evacuate others	(5.1)	—		—	(20.6)

Since the number of people in the two samples is so different we must be rather cautious about drawing firm conclusions. However it is apparent that the range of actions taken in buildings with less than 100 people present is much greater. We are also struck by the differences in First Actions taken. For example, almost twice as many individuals undertake contacting of the Fire Brigade as a First Action in the first group. The proportion of people investigating in the large number of occupants sample is, in contrast, very much greater. One further point is that where less than 100 people are present, individuals tend to investigate first, and then do something else. In buildings with more than 100 people present, individuals tend to warn others or contact the Fire Brigade before investigating, an action sequence which is frequent in Institution category buildings, suggesting that they make up a substantial part of this sample.

10.2.2 EVACUATION IN RELATION TO LARGE NUMBER OF BUILDING OCCUPANTS

We will again examine evacuation in two ways. Firstly, in terms of individual respondants and, secondly, the proportion of people leaving each incident. The cross-tabulation of the number of people in the building against whether an individual left the building is shown in Table 57 below.

TABLE 57. Number of building occupants by evacuation behaviour

Leave the building	Number of people in building		Total
	Up to 99	100 or more	
Not leave	862 (85.8) (43.6)	143 (14.2) (66.8)	1005 (45.8)
Leave	1117 (94.0) (56.4)	71 (6.0) (33.2)	1188 (54.2)
Total	1979 (90.2)	214 (9.8)	2193 (100.0)

The values in Table 57 indicate than in buildings containing large numbers of people, individuals were much less likely to leave the building ($\chi^2 = 42.1$ (1 df), significant beyond the 0.001 level). We might, however, speculate that this conclusion may be spurious simply due to bias in our sample of interviewees. Obviously a much smaller proportion of the building occupants were interviewed at incidents when there were large numbers, and it might be suggested that the Fire Brigade officers tended to select occupants who left. We can examine this hypothesis by looking at the proportion of people who left each incident, as shown in Table 58 overleaf.

The χ^2 calculation based upon the proportions in Table 58 gives a value of 53.9 (4 df), which is significant beyond the 0.001 level. Buildings with less than 100 people have less than the expected frequency of incidents where no-one left, and more than the expected frequency of incidents where everyone left. The converse applies to buildings with more than 100 people. We can therefore see that this analysis supports our earlier one, in that people were less likely to leave buildings with large numbers of people present, and that there does not appear to be an obvious bias in the interviewing.

TABLE 58. Proportion of people leaving by number of building occupants

Number of people in building	Proportion of people leaving building					Total
	0%	1% to 30%	31% to 70%	71% to 99%	100%	
Up to 99	259 (29.0) (87.8)	46 (5.2) (80.7)	92 (10.3) (97.9)	40 (4.5) (95.2)	456 (51.1) (98.3)	893 (93.8)
More than 100	36 (61.0) (12.2)	11 (18.6) (19.3)	2 (3.4) (2.1)	2 (3.4) (4.8)	8 (13.6) (1.7)	59 (6.2)
Total	295 (31.0)	57 (6.0)	94 (9.9)	42 (4.4)	464 (48.7)	952 (100.0)

One further way we can examine the data for any association between the number of occupants and the proportion of people leaving is by calculating a correlation coefficient for the two variables. In this case both variables are uncategorised (i.e. in raw form). Calculating R for these two variables gives a value of -.216 (significant at the 0.001 level), suggesting that as the number of occupants increases, the proportion of people leaving decreases, which lends further support to our earlier findings.

10.2.3 RETURNING INTO THE BUILDING IN RELATION TO NUMBER OF BUILDING OCCUPANTS

The cross-tabulation of the above two variables is shown in Table 59 below.

TABLE 59. Number of occupants by return into the building

Return into the building	Number of people in building		Total
	Up to 99	100 or more	
Not return	607 (91.3) (54.3)	58 (8.7) (81.7)	665 (56.0)
Return	510 (97.5) (45.7)	13 (2.5) (18.3)	523 (44.0)
Total	1117 (94.0)	71 (6.0)	1188 (100.0)

The proportions clearly show that people are much less likely to return into buildings with large numbers of occupants ($\chi^2 = 20.2$ (1 df), which is significant beyond the 0.001 level).

10.2.4 MOVEMENT THROUGH SMOKE IN RELATION TO NUMBER OF BUILDING OCCUPANTS

The cross-tabulation of the number of people in the building against whether or not individuals moved through smoke is shown in Table 60 overleaf. The χ^2 calculation from frequencies in this table gives a value of 5.65 (1 df), which fails to reach the 0.01 level of probability. We can therefore state that there is no association between movement through smoke and the number of people in the building.

TABLE 60. Number of occupants by movement through smoke

Move through smoke	Number of people in building		Total
	Up to 99	100 or more	
Not move	692 (90.0) (39.6)	77 (10.0) (49.3)	769 (40.4)
Move	1055 (93.0) (60.4)	79 (7.0) (50.7)	1134 (59.6)
Total	1747 (91.8)	156 (8.2)	1903 (100.0)

10.3 BEHAVIOUR IN HIGH-RISE FLATS

The concept of high-rise flats has received considerable criticism in recent years, and in fact this type of building is no longer being constructed. The criticisms levelled at them have ranged from faults in design and construction, to their socially isolating and psychologically depressing effects. Informal discussion with the occupants of these flats often uncovers a long list of complaints, frequently including some reference to the fact that Fire Brigade appliances could not reach above a certain level. It would seem therefore that these people may be particularly aware of fire dangers, and in view of this awareness and the specific nature of the building, we must be specially interested in the behaviour which is manifest in them.

Of the 598 Dwellings in our sample, some 17 (2.8%) fall into the category of high-rise flats, that is, having more than 6 storeys. From the 17 incidents, 35 occupants were interviewed.

10.3.1 SEQUENCES OF ACTION IN HIGH-RISE FLATS

With such a small sample of respondents in this group and a proportionately large sample in low-rise dwellings, comparisons between the two are not very meaningful. We will, however, illustrate the most frequent action sequences in the high-rise flats.

First Action	%	Second Action	%	Third Action	%
(a) Investigate	(31.4) →	——	→	——	(54.5)
(b) Contact FB	(17.1) →	——	→	——	(33.3)

As can be seen, the tendency in high-rise flats seems to be to simply undertake one course of action. Some 25% of the occupants warned other people at some stage, and almost 23% undertook fire-fighting, as either First, Second or Third Actions. It appears that the perceived need to investigate a fire may be rather stronger in high-rise flats, representing as it does 31.4% of the First Actions, as opposed to the 17.7% of the First Actions in low-rise dwellings. However the small sample must make us treat any conclusion of this nature with great caution.

10.3.2 EVACUATION BEHAVIOUR IN HIGH-RISE FLATS

High-rise flats are not designed on the premise that the whole building will be evacuated of all occupants when there is a fire. In the event of a fire in one flat (or on one floor), it is assumed that the occupants of the other flats will remain behind their front doors (which are half-hour fire-resistant), safe within their flats which are constructed as fire-resistant compartments. The fact that this behaviour is contrary to what people often do in non-high-rise dwellings is, to a certain extent, recognised by the Local Authorities who are usually responsible for the buildings. In some cases a card is issued to new tenants* telling them what they should do in the event of fire. In others, instructions are printed in Rent Books. The extent to which these messages "get across" is largely unknown.

As before, we can examine evacuation in two ways, at the individual interviewee level, and also in terms of the proportion of people leaving each incident. The cross-tabulation of whether or not people left the building in relation to low and high-rise dwellings is shown in Table 61 below.

TABLE 61. Number of storeys by evacuation behaviour in Dwellings

Leave the building	Number of storeys			Total
	4 or less	5	6 or more	
Not leave	373 (90.5) (34.2)	12 (2.9) (40.0)	27 (6.6) (77.1)	412 (35.7)
Leave	717 (96.5) (65.8)	18 (2.4) (60.0)	8 (1.1) (22.9)	743 (64.3)
Total	1090 (94.4)	30 (2.6)	35 (3.0)	1155 (100.0)

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* In some areas these cards are only issued to the <u>first</u> tenants of the flats. Since there is often quite a high turnover in tenants, subsequent occupants presumably remain ignorant of these instructions.

It can be seen from Table 61 that, for the categories chosen, a progressively smaller percentage of people leave the building as the number of storeys increases. This is especially noticeable once the number of storeys is greater than 5, which is regarded as the point where high-rise starts. This trend is confirmed by the χ^2 test ($\chi^2 = 27.4$ (2 df), significant beyond the 0.001 level).

Again, we will divide the proportion of people leaving the building into 5 categories, and the cross-tabulation of this against low and high-rise dwellings is shown in Table 62 below.

TABLE 62. Number of storeys by proportion of people leaving dwellings

Proportion leaving building	Number of storeys			Total
	4 or less	5	6 or more	
0%	158 (91.4) (24.2)	0 (0.0) (0.0)	13 (8.6) (76.5)	151 (25.3)
1% to 30%	23 (79.3) (4.0)	3 (10.3) (27.3)	3 (10.3) (17.6)	29 (4.8)
31% to 70%	61 (96.8) (10.7)	2 (3.2) (18.2)	0 (0.0) (0.0)	63 (10.5)
71% to 99%	19 (100.0) (3.3)	0 (0.0) (0.0)	0 (0.0) (0.0)	19 (3.2)
100%	329. (97.9) (57.7)	6. (1.8) (54.5)	1. (0.3) (5.9)	336 (56.2)
Total	570 (95.3)	11 (1.8)	17 (2.8)	598 (100.0)

The expected values in a large proportion of the cells in the above table are very low, which prevents us from testing directly. However, inspection of the table confirms our earlier finding that occupants are much less likely to leave high-rise dwellings than they are to leave low-rise dwellings.

One further way in which we can explore this association is to compute the correlation between the number of storeys (in dwellings) and the proportion of people who leave. Calculating Pearson's R for the two variables yields a value of -.233 (significant beyond 0.001), which suggests that as the number of storeys increases, the proportion of occupants who leave decreases.

10.3.3 RETURNING INTO HIGH-RISE FLATS

It is clear that a much smaller proportion of people tend to leave high-rise flats than other types of dwellings. We will now examine the re-entry behaviour of these people. The cross-tabulation of return into the building against the number of storeys is shown in Table 63 below.

TABLE 63. Number of storeys by return into dwellings

Return into building	Number of storeys			Total
	4 or less	5	6 or more	
Not return	396 (96.1) (55.2)	14 (3.4) (77.8)	2 (0.5) (25.0)	412 (35.7)
Return	321 (97.0) (44.8)	4 (1.2) (22.2)	6 (1.8) (75.6)	331 (64.3)
Total	717 (96.5)	18 (2.4)	8 (1.1)	743 (100.0)

The expected values in half the cells of Table 63 are below 5 and we cannot therefore undertake meaningful significance testing. Inspection of the table, however, indicates that individuals seem more likely to return into high-rise flats than other types of dwelling. We must treat such an interpretation with some caution however. Firstly, it is based upon such small frequencies, and secondly the question, "Did you return into the building during the course of the fire?" may well have had a different meaning for occupants of high-rise flats. The "building" in this question is a very large construction in which the majority of the occupants may in fact be unaware of a fire. Leaving a building which has a fire on the seventh floor, for example, then re-entering on the ground floor and remaining there, is clearly not comparable to leaving/re-entering a two-storey dwelling during the course of the fire. We are suggesting therefore that whilst the behaviour in both cases may be superficially similar, due to the entirely different nature of the buildings, they are not comparable in any real sense in terms of the hazard involved.

10.3.4 MOVEMENT THROUGH SMOKE IN HIGH-RISE FLATS

Dwellings in general tend to have a large proportion of people moving through smoke. We will examine high-rise flats to see if this behaviour is also manifest in this type of occupancy in Table 64 overleaf.

TABLE 64. Number of storeys by movement through smoke in dwellings

Move through smoke	Number of storeys			Total
	4 or less	5	6 or more	
Not move	367 (94.6) (36.6)	6 (1.5) (22.2)	15 (3.9) (46.9)	388 (36.5)
Move	637 (94.4) (63.4)	21 (3.1) (77.8)	17 (2.5) (53.1)	675 (63.5)
Total	1004 (94.4)	27 (2.5)	32 (3.1)	1063 (100.0)

There is no significant difference between the categories in Table 64 ($\chi^2 = 3.8$ (2 df), non-significant). We therefore conclude that individuals in high-rise flats are no more nor less likely to move through smoke than people in other types of dwelling.

10.4 DISCUSSION

The evidence of this chapter suggests that the behaviour of building occupants in fires is associated with the characteristics of the building. The most diverse patterns of behaviour occur in Dwellings, although these often include some action to minimise the risk and contacting the Fire Brigade. In contrast, behaviour in Industrial category buildings falls into a smaller number of categories, for example the three most popular First Actions in Dwellings account for 42.6% of all the First Actions, whereas the three most popular First Actions in Industrial buildings account for 60.3% of the First Actions. Much of the behaviour in Industrial buildings is directed towards fire-fighting. In Retail category buildings fire-fighting is also a frequent response, although in this case it is often associated with contacting the Fire Brigade. In the Institution category a much smaller percentage undertake fire-fighting, but often warn others before investigating the nature of the fire, a reaction which is peculiar to this building category.

The number of building occupants also affects the action sequences, although as we have pointed-out earlier, our division into two categories may be considered somewhat arbitrary. Certainly there exist differences between these categories, the major ones being that the range of actions is broader in buildings containing few occupants. The large proportion who investigate as a First Action in buildings with large numbers of occupants may result from the inclusion of high-rise flats in this category, since this behaviour is a notable feature in these buildings. Similarly, the relatively large percentage of individuals who warn others and then investigate are probably the same ones about whom we have commented in the Institutional category.

With regard to evacuation, that is, whether people left the building at all during the course of the fire, Dwellings stand out as having a disproportionately large number of occupants who leave, as do buildings with less than 100 occupants. It is interesting, however, that occupants are <u>less</u> likely to leave high-rise flats than other types of dwelling, a finding which must be of encouragement to those who administer these buildings. The finding that people also seem more likely to return into high-rise flats during the course of the fire must be treated with some caution as has already been discussed, since re-entry into a low-rise building in which there is a fire has a completely different connotation to re-entry into a high-rise building in the same circumstances. Otherwise re-entry behaviour is independent of building category, although it is more likely in buildings with few occupants than with those with many occupants.

Movement through smoke is the one Behavioural variable which appears to be relatively independent of the Building variables, the only significant association being that disproportionately fewer people undertake this action in Industrial category buildings. We may speculate that this reflects the higher level of training in this category of building which was demonstrated in Chapter 9; however we will directly explore the association between these two variables in the next chapter.

CHAPTER 11

PERSONAL VARIABLES & BEHAVIOUR

11.0 PERSONAL VARIABLES AND BEHAVIOUR

In the previous chapter is has been demonstrated that certain of our Building variables are associated with particular behaviour in fires. We now turn our attention to the effect which Personal variables may have upon such behaviour. As in Chapter 10, we will examine in order, four aspects of behaviour, namely the sequences of action which individuals undertook, whether they left or re-entered the building during the course of the fire, and whether they moved through smoke.

11.1 EFFECT OF PERSONAL VARIABLES ON SEQUENCES OF ACTION

We will consider the effect of seven Personal variables upon behaviour patterns. As before, First Actions are presented in descending order of frequency in each case.

11.1.1 SEQUENCES OF ACTION IN RELATION TO SEX OF THE INDIVIDUAL

The most frequent action sequences undertaken by the 953 women who were interviewed are presented below.

First Action	%	Second Action	%	Third Action	%
(a) Alert others	(13.2)	Contact FB	(20.6)	——	(38.5)
				Fire-fight	(19.2)
		Evacuate self	(17.5)	——	(72.7)
(b) Investigate	(13.2)	Contact FB	(16.7)	——	(42.6)
		Minimise risk	(15.1)	Contact FB	(36.8)
		Fire-fight	(13.5)	——	(35.3)
				Contact FB	(35.3)
(c) Contact FB	(13.1)	Something else *	(19.2)	——	(62.5)
		Fire-fight	(16.0)	——	(45.0)
		Evacuate others	(12.8)	——	(50.0)
				Evacuate self	(31.3)
(d) Evacuate self	(11.6)	-		——	(48.6)
		Contact FB	(16.2)	——	(77.8)
(e) Minimise risk	(10.9)	Contact FB	(18.3)	Evacuate self	(21.1)
		Fire-fight	(12.4)	Contact FB	(69.2)
(f) Evacuate others	(10.8)	Contact FB	(23.3)	——	(41.6)
		Evacuate self	(13.6)	——	(57.1)
(g) Fire-fight	(7.9)	Contact FB	(34.6)	——	(26.9)
				Minimise risk	(26.9)

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* Most commonly, saving personal effects.

The most frequent action sequences undertaken by the 1240 men who were interviewed are presented below.

First Action	%	Second Action	%	Third Action	%
(a) Investigate	(21.3)	Fire-fight	(30.6)	——	(65.4)
		Contact FB	(13.2)	——	(28.6)
				Fire-fight	(25.7)
(b) Fire-fight	(20.4)	——		——	(28.5)
		Contact FB	(20.6)	——	(34.6)
				Fire-fight	(25.0)
(c) Contact FB	(12.9)	Fire-fight	(27.5)	——	(75.0)
		Investigate	(16.9)	Fire-fight	(40.1)
(d) Alert others	(12.7)	Fire-fight	(31.8)	——	(68.0)
		Evacuate self	(12.1)	——	(73.7)
		Investigate	(11.5)	——	(33.3)
(e) Minimise risk	(9.5)	Fire-fight	(25.2)	——	(46.7)
				Contact FB	(26.7)
		Contact FB	(21.8)	Fire-fight	(34.6)
(f) Evacuate self	(8.1)	——		——	(62.0)
(g) Evacuate others	(4.4)	Contact FB	(23.6)	Fire-fight	(38.5)

Inspection of the two sets of action sequences shows immediately that the behaviour patterns of men and women differ. If we look first at the relative order and percentages of the First Actions taken, we find that for women, alerting others is the most popular action with investigating, closely followed by contacting the Fire Brigade. Contrast this with men, where fire-fighting is almost as frequent as investigating, and contacting the Fire Brigade is considerably less frequent. It is also obvious that womens' First Actions are much more evenly distributed, the difference in percentage between the most popular First Action and the least popular being only 5.3%, whereas a similar comparison for men shows a difference of nearly 17%. One final notable point concerning First Actions is the fact that evacuating others is undertaken more than twice as frequently by women as by men.

If we look now at the sequences of actions we see that women are largely concerned with warning others and evacuation, whilst in contrast the action sequences of the men are dominated by the Fire-fight or Fire-fight/contact Fire Brigade type of sequence.

11.1.2 SEQUENCES OF ACTION IN RELATION TO AGE OF THE INDIVIDUAL

We have earlier divided the age of those interviewed into eight categories for the purpose of analysis. However, providing complete action sequences for each age group would be exhaustive in more than one sense of the word, and we have therefore in this case restricted the presentation to a summary of the salient points.

(i) Age range 0 to 10 years

The two most frequent action sequences for the 32 individuals interviewed were:

(a)	To evacuate oneself from the building immediately →	(28.1)
(b)	To first alert others and then leave the building →	(25.0)

(ii) Age range 11 to 20 years

The three most frequent action sequences for the 254 individuals interviewed were:

	First Action	%	Second Action		Third Action	
(a)	Investigate	(20.1) →	Fire-fight	(21.6) →	——	(72.2)
(b)	Alert others	(16.5) →	Evacuate self	(21.4) →	——	(100.0)
(c)	Evacuate self	(15.0) →	——	→	——	(60.5)

(iii) Age range 21 to 30 years

The most frequent action sequences for the 582 individuals interviewed were:

	First Action	%	Second Action	%	Third Action	%
(a)	Investigate	(17.4) <	Fire-fight	(22.7) →	——	(60.9)
			Minimise risk	(14.9) <	——	(33.3)
					Fire-fight	(33.3)
(b)	Fire-fight	(14.9) <	——	→	——	(35.6)
			Contact FB	(24.1) <	——	(28.6)
					Minimise risk	(23.8)
(c)	Alert others	(13.6) <	Fire-fight	(24.0) →	——	(63.2)
			Evacuate self	(15.2) →	——	(50.0)
(d)	Contact FB	(12.5) →	Fire-fight	(20.5) →	——	(66.7)
(e)	Evacuate others	(11.9) <	-	→	——	(50.7)
			Contact FB	(18.8) →	——	(61.5)

(iv) Age range 31 to 40 years

The most frequent action sequences for the 550 individuals interviewed were:

First Action	%	Second Action	%	Third Action	%
(a) Fire-fight	(16.4)	——		——	(44.4)
		Contact FB	(17.8)	Fire-fight	(31.3)
				Minimise risk	(31.3)
(b) Investigate	(16.4)	Fire-fight	(27.8)	——	(68.0)
		Contact FB	(18.9)	Fire-fight	(29.4)
(c) Contact FB	(15.3)	Fire-fight	(20.2)	——	(64.7)
		Evacuate self	(11.9)	——	(80.0)

(v) Age range 41 to 50 years

The most frequent action sequences for the 384 individuals interviewed were:

First Action	%	Second Action	%	Third Action	%
(a) Investigate	(18.5)	Fire-fight	(23.9)	——	(70.6)
		Contact FB	(23.9)	Fire-fight	(17.6)
				Minimise risk	(11.8)
(b) Fire-fight	(17.0)	——		——	(20.0)
		Contact FB	(27.7)	——	(33.3)
				Increase risk	(27.2)
				Fire-fight	(16.7)
(c) Alert others	(14.6)	Contact FB	(14.3)	——	(25.0)
				Investigate	(25.0)
		Fire-fight	(14.3)	——	(100.0)
(d) Contact FB	(14.1)	Fire-fight	(24.1)	——	(61.5)
		Investigate	(16.7)	Fire-fight	(33.3)

(vi) Age range 51 to 60 years

The most frequent action sequences for the 241 individuals interviewed were:

First Action	%	Second Action	%	Third Action	%
(a) Investigate	(19.1)	Fire-fight	(28.3)	——	(46.2)
				Contact FB	(30.8)
		Contact FB	(17.4)	——	(37.5)
(b) Fire-fight	(18.7)	——		——	(35.6)
		Contact FB	(28.9)	——	(53.8)
(c) Minimise risk	(14.1)	Alert others	(23.5)	Contact FB	(37.5)
		Contact FB	(17.6)	Fire-fight	(50.0)
		Fire-fight	(17.6)	——	(50.0)
(d) Contact FB	(13.7)	Fire-fight	(36.4)	——	(66.7)

(v) Age range 61 to 70 years

The most frequent action sequences for the 95 individuals interviewed were:

First Action	%		Second Action	%		Third Action	%
Investigate	(21.1)	→	Fire-fight	(25.0)	→	——	(40.0)
Fire-fight	(14.7)	→	——		→	——	(42.9)
Contact FB	(12.6)	→	Alert others	(25.0)	→	——	(66.7)

(vi) Age range over 70 years

The most frequent action sequences for the 55 individuals interviewed were:

First Action	%		Second Action	%		Third Action	%
Investigate	(16.4)	→	Fire-fight	(33.3)	→	——	
		→	Increase risk	(22.2)	→	——	
Fire-fight	(12.7)	→	Contact FB	(28.6)	→	——	(100.0)
Contact FB	(10.9)	→	Evacuate self	(33.3)	→	——	(100.0)

Although there are clear differences in the percentages and order of First Actions between the age groups, which we will discuss more fully in a moment, perhaps the most striking aspect of the action sequences is their relative uniformity across all age groups. Behaviour patterns such as

Investigate → Fire-fight
Investigate → Contact FB
Contact FB → Fire-fight

all tend to occur with some fairly high frequency in each category, whilst single basic courses of action such as

Fire-fight → —— → ——
Evacuate self → —— → ——

also occur quite frequently.

In the younger age ranges, the action sequence

Alert others → Evacuate self

is fairly common, whereas in the only other category in which alerting others is a frequent First Action, age range 41 to 50 years, it is followed by either fire-fighting or contacting the Fire Brigade. A further peculiarity of this age group is that only in this group does investigating appear as an action other than as a First Action, in one case after first alerting others and contacting the Fire Brigade, and in another after first contacting the Fire Brigade.

Turning now to First Actions, a number of points are of interest which are perhaps best illustrated in Figure 18 (a,b,c,d). It will be seen in Figure 18 (a) that as a First Action, evacuating others is strongly concentrated in the age range 21 to 40 years, when we would expect young children to be present in the building. In Figure 18 (b) it can be seen that the proportion of individuals who choose fire-fighting as a First Action increases progressively up to the age of 60. Figure 18 (c) illustrates that contacting the Fire Brigade increases sharply in frequency up to the age range 31 to 40 years, which is the mode, and then falls gradually away in popularity as a First Action. Finally, we can see that immediately leaving the building is very much associated with the younger age groups, once above age 30 it remains at a fairly constant 6% to 8% (Figure 18(d).

11.1.3 SEQUENCES OF ACTION IN RELATION TO SUBJECTIVE SERIOUSNESS RATING OF THE FIRE

We will illustrate the most common action sequences for the three levels of seriousness. The most frequent action sequences for the 648 individuals who judged the fire to be "not at all" serious are shown below.

First Action	%	Second Action	%	Third Action	%
(a) Investigate	(20.8)	Fire-fight	(25.5)	——	(68.6)
		Contact FB	(11.7)	——	(50.0)
(b) Fire-fight	(17.9)	——		——	(41.4)
		Contact FB	(22.4)	——	(34.6)
				Fire-fight	(23.1)
(c) Alert others	(11.6)	Fire-fight	(29.3)	——	(68.1)
		Contact FB	(13.3)	——	
(d) Minimise risk	(11.0)	Fire-fight	(18.3)	——	(61.5)
		Alert others	(16.9)	——	(41.6)
(e) Contact FB	(9.6)	Fire-fight	(29.3)	——	(75.0)
(f) Evacuate self	(8.5)	——		——	(67.3)

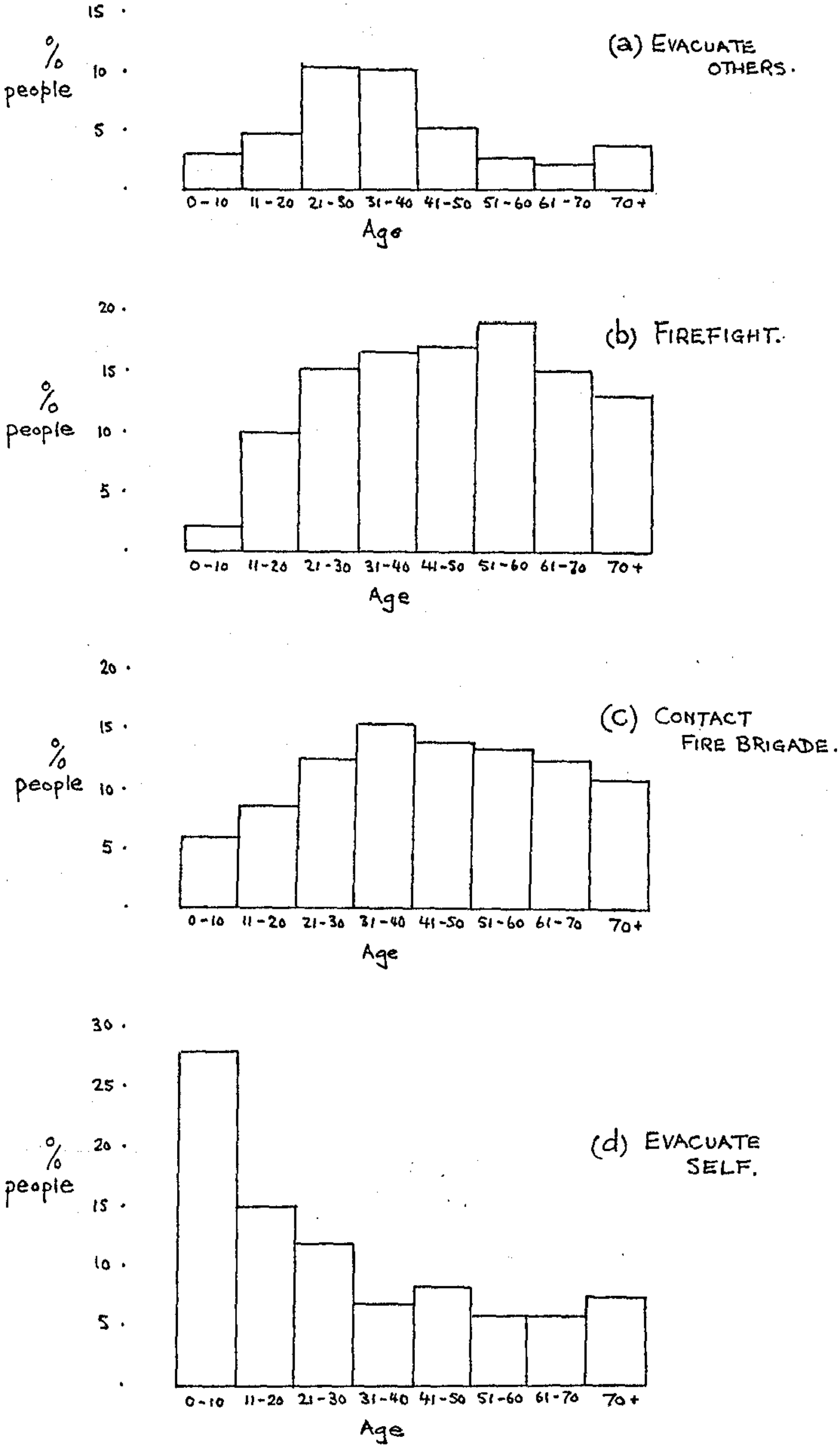


FIGURE 18. Percentage distribution of main First Actions by age

The most frequent action sequences for the 1104 individuals who judged the fire to be "quite" serious are presented below.

First Action	%	Second Action	%	Third Action	%
(a) Investigate	(17.1)	Fire-fight	(25.9)	——	(59.2)
				Contact FB	(14.3)
		Contact FB	(16.4)	Fire-fight	(25.8)
		Minimise risk	(14.3)	Contact FB	(25.9)
(b) Contact FB	(14.6)	Fire-fight	(23.5)	——	(65.8)
		Minimise risk	(8.0)	——	(62.5)
(c) Fire-fight	(14.2)	——		——	(16.6)
		Contact FB	(27.4)	Fire-fight	(25.6)
				——	(25.6)
(d) Alert others	(12.8)	Fire-fight	(22.0)	——	(61.3)
		Contact FB	(13.5)	Fire-fight	(31.6)
		——		——	(17.0)
(e) Minimise risk	(10.4)	Contact FB	(26.1)	Fire-fight	(30.0)
				Evacuate self	(20.0)
		Minimise risk	(13.9)	Contact FB	(62.5)
		Fire-fight	(13.0)	Contact FB	(69.2)
(f) Evacuate self	(9.1)	——		——	(64.0)

The most frequent action sequences for the 441 individuals who judged the fire to be "extremely" serious are presented below.

First Action	%	Second Action	%	Third Action	%
(a) Alert others	(15.2)	Evacuate self	(17.9)	——	(66.7)
		Retreat from fire	(14.9)	Request assist	(30.0)
		Fire-fight	(13.4)	——	(77.8)
(b) Investigate	(14.7)	Fire-fight	(21.5)	——	(42.9)
(c) Contact FB	(13.8)	Alert others	(16.4)	——	(40.0)
		Fire-fight	(16.4)	——	(50.9)
(d) Evacuate self	(12.6)	——		——	(42.9)
		Contact FB	(23.3)	——	(61.5)
(e) Fire-fight	(12.5)	——		——	(23.6)
		Contact FB	(16.4)	——	(55.6)
(f) Evacuate others	(9.5)	Contact FB	(23.8)	Minimise risk	(20.0)
		Evacuate self	(19.0)	——	

Study of the breakdown of actions at the three levels of seriousness shows considerable differences. If we look first at the percentages of First Actions, we see that in 6 of the 7 action categories there are consistent changes. We find that as the seriousness of the fire is judged to increase, the percentage of people who investigate, fire-fight and minimise risk consistently falls, whilst the percentage of people who alert others, evacuate others and evacuate themselves consistently rises.

The only First Action which departs from the trend is contacting the Fire Brigade, which rises sharply once the fire is rated "quite" serious and then falls very slightly at "extremely" serious.

With regard to the action sequences, as before, the patterns Investigate → Fire-fight and Contact FB → Fire-fight (or vice-versa) appear in each group; however it is when the fire is rated "quite" serious that this type of sequence is most common. It is also at the "quite" level that efforts to minimise the risk appear in the behaviour patterns. At other levels it appears only as a First Action, or, in the case of fires ranked "extremely" serious, does not appear at all in the sequences of actions.

In summary it would seem that the general behaviour of the individual differs depending upon how serious they consider the fire to be. At the low levels of seriousness the concern is mainly with fire-fighting and contacting the Fire Brigade, at the medium level it is these actions plus minimising the risk, and at the high level it shifts to alerting others and evacuating oneself and others from the building.

11.1.4 ACTION SEQUENCES IN RELATION TO FAMILIARITY WITH THE BUILDING

Our categorisation of familiarity is that which we have used in earlier analyses, "completely familiar with the building" and "less than completely familiar with the building". Unfortunately the latter group represents only 15% of the total sample, and we are therefore comparing two groups of very disparate size.

The action sequences for the 330 occupants interviewed who were less than completely familiar with the layout of the building are shown below.

First Action	%	Second Action	%	Third Action	%
(a) Investigate	(21.2)	——		——	(18.6)
		Fire-fight	(15.7)	——	(72.7)
(b) Alert others	(14.5)	Fire-fight	(27.1)	——	(53.8)
		Contact FB	(16.7)	——	(50.0)
(c) Fire-fight	(12.7)	——		——	(26.2)
(d) Evacuate self	(12.4)	——		——	(75.6)
(e) Contact FB	(10.9)	Fire-fight	(19.4)	——	(71.4)
(f) Minimise risk	(6.1)	——		——	(30.0)
(g) Evacuate others	(3.0)	——		——	(20.0)

The action sequences for the 1863 occupants interviewed who were completely familiar with the layout of the building are shown below.

First Action	%	Second Action	%	Third Action	%
(a) Investigate	(17.2)	Fire-fight	(27.1)	——	(58.6)
				Contact FB	(14.9)
		Contact FB	(16.2)	——	(25.0)
				Fire-fight	(19.2)
		Minimise risk	(13.4)	Contact FB	(27.9)
				Fire-fight	(18.6)
(b) Fire-fight	(15.4)	——		——	(21.7)
		Contact FB	(24.8)	——	(32.4)
				Fire-fight	(21.1)
				Minimise risk	(16.9)
(c) Contact FB	(13.4)	Fire-fight	(22.9)	——	(64.9)
		Investigate	(11.6)	Fire-fight	(31.0)
		Evacuate self	(9.6)	——	(79.2)
		Evacuate others	(9.2)	Alert others	(30.4)
				——	(26.1)
(d) Alert others	(12.6)	Fire-fight	(20.9)	——	(67.3)
		Evacuate self	(14.5)	——	(70.6)
		Contact FB	(12.3)	Fire-fight	(20.7)
				Evacuate others	(17.2)
(e) Minimise risk	(10.9)	Contact FB	(21.2)	Fire-fight	(25.6)
				——	(18.6)
		Fire-fight	(15.7)	——	(43.8)
				Contact FB	(34.4)
		Alert others	(14.3)	Contact FB	(37.9)
				——	(20.9)
		Minimise risk	(11.3)	Contact FB	(47.8)
(f) Evacuate self	(9.1)	——		——	(56.5)
(g) Evacuate others	(7.9)	Contact FB	(23.6)	——	(28.6)
				Fire-fight	(20.7)
		Fire-fight	(14.9)	Contact FB	(22.7)
				——	(22.7)
		Minimise risk	(14.9)	Contact FB	(45.5)

Comparing our two samples, "completely familiar" and "less than completely familiar" is a little difficult in terms of sequences of actions due to the differences in numbers. However one point emerges is that the sequence "do something" → Contact FB, which is very frequent in the "completely familiar" group, only occurs when individuals alert others in the "less than completely familiar" group. In fact contacting the Fire Brigade is relatively rare in this group, both as a First Action and as a pattern of actions, in contrast to the "completely familiar" group.

It can be seen when considering first actions that there are some interesting differences between the two samples. For example, a relatively large percentage of individuals who are unfamiliar with the building appear to leave immediately and investigate, whilst fire-fighting is very common if people are familiar with the building. It is also interesting that although evacuating others is the least popular of the first actions for both groups, more than twice as many individuals do this who are familiar with the building as who are unfamiliar.

11.1.5 ACTION SEQUENCES IN RELATION TO FREQUENCY OF TRAINING

As with familiarity, our division of training frequency gives us two samples of rather disparate size, with those who have never received training making up nearly 80% of the sample.

The action sequences for the 457 occupants interviewed who had received some training are presented below.

First Action		Second Action		Third Action	%
(a) Investigate	(20.8)	——		——	(12.6)
		Fire-fight	(34.7)	——	(63.6)
(b) Alert others	(17.7)	Fire-fight	(38.3)	——	(71.0)
		Investigate	(17.3)	Fire-fight	(35.7)
(c) Fire-fight	(16.0)	——		——	(23.3)
		Contact FB	(22.0)	Fire-fight	(37.5)
				——	(25.0)
(d) Contact FB	(14.2)	Fire-fight	(24.6)	——	(62.5)
		Investigate	(18.5)	——	(25.0)
		Alert others	(16.9)	——	(54.5)
(e) Minimise risk	(8.3)	Fire-fight	(15.8)	——	(50.0)
		Evacuate others	(13.2)	——	(40.0)
(f) Evacuate self	(8.1)	——		——	(70.3)
(g) Evacuate others	(5.5)	Fire-fight	(20.0)	——	(40.0)
		Retreat from fire	(16.0)	——	(100.0)

The action sequences for the 1736 occupants interviewed who had never received training are presented below.

First Action	%	Second Action	%	Third Action	%
(a) Investigate	(17.1)	——		——	(7.8)
		Fire-fight	(22.0)	——	(58.5)
		Contact FB	(16.2)	——	(31.3)
		Minimise risk	(10.0)	Contact FB	(27.9)
				——	(25.6)

First Action	%	Second Action	%	Third Action	%
(b) Fire-fight	(14.7)	——		——	(22.0)
		Contact FB	(16.2)	——	(33.9)
				Minimise risk	(17.7)
(c) Contact FB	(12.7)	Fire-fight	(21.8)	——	(66.7)
		Evacuate self	(9.5)	——	(81.0)
		Minimise risk	(10.0)	——	(50.0)
(d) Alert others	(11.6)	Evacuate self	(17.3)	——	(68.6)
		Contact FB	(16.3)	——	(21.2)
				Fire-fight	(24.2)
		Fire-fight	(15.3)	——	(58.1)
(e) Minimise risk	(10.7)	Contact FB	(21.6)	Fire-fight	(25.0)
		Fire-fight	(16.8)	——	(41.9)
				Contact FB	(35.5)
(f) Evacuate self	(10.0)	——		——	(57.5)
		Contact FB	(16.1)	——	(50.0)
(g) Evacuate others	(7.7)	Contact FB	(24.3)	Fire-fight	(27.8)
				——	(25.0)
		Minimise risk	(15.8)	Contact FB	(47.6)

Perhaps the over-riding impression we gain from studying the above patterns of behaviour of our trained and untrained groups, is how much more focussed is the behaviour of the trained sample, in the sense that a greater percentage choose to undertake a smaller number of actions. As an example of this, the four most frequent First Actions of the trained group account for 69% of the First Actions, whilst the four most frequent of the untrained group account for only 56% of the First Actions. A further example is provided by study of fire-fighting, which as can be seen appears fairly frequently in the action sequences of both groups, however in each case a greater percentage of trained individuals elect to undertake it.

Whilst there are some similarities between the actions of the groups there are also several areas of difference. For instance, whilst a greater percentage of trained individuals contact the Fire Brigade as a First Action, after that it appears very infrequently as an action in their behaviour patterns, whilst it is a very common component of the action sequences of the untrained group. Similarly, attempts to minimise the risk appear exclusively in the action sequences of the untrained, other than as a First Action. In contrast, both as a First Action and an element of an action sequence, alerting others is much more likely to be associated with the trained group. One final point of interest is that in our trained sample we see the sequence "Do something" and then Investigate occurring on two occasions, a very unusual pattern, only previously noted when examining the effect of building category on behaviour. It is likely that these individuals, who were the occupants of Institution category buildings, are re-appearing in our trained group.

11.1.6 ACTION SEQUENCES IN RELATION TO PREVIOUS INVOLVEMENT IN A FIRE INCIDENT

The disparity between the sample sizes is less for previous involvement than for the immediately preceding two variables. In this case, our sample of individuals who claim to have had previous experience of fire account for almost 30% of the total sample.

The action sequences for the 653 occupants interviewed who had been previously involved in a fire incident are presented below.

	First Action	%	Second Action	%	Third Action	%
(a)	Investigate	(22.1)	Fire-fight	(31.9)	——	(41.3)
			Minimise risk	(12.5)	——	(33.3)
(b)	Fire-fight	(19.1)	——		——	(33.6)
			Contact FB	(25.6)	——	(34.4)
					Fire-fight	(28.1)
					Minimise risk	(25.0)
(c)	Alert others	(13.5)	Fire-fight	(39.8)	——	(74.3)
			Investigate	(12.5)	Fire-fight	(36.4)
(d)	Contact FB	(12.1)	Fire-fight	(30.4)	——	(62.5)
			Investigate	(16.4)	Fire-fight	(38.5)
(e)	Minimise risk	(11.8)	Fire-fight	(22.2)	——	(62.5)
			Evacuate self	(18.1)	——	(38.5)
			Contact FB	(16.7)	Fire-fight	(33.3)
(f)	Evacuate self	(6.1)	——		——	(60.0)

The action sequences for the 1540 interviewed who had not been previously involved in a fire incident are presented below.

	First Action	%	Second Action	%	Third Action	%
(a)	Investigate	(16.0)	Fire-fight	(21.1)	——	(55.8)
					Contact FB	(17.3)
			Contact FB	(16.2)	——	(22.5)
					Fire-fight	(17.5)
					Minimise risk	(15.0)
			Minimise risk	(13.4)	Contact FB	(24.2)
					Fire-fight	(24.2)
(b)	Contact FB	(13.4)	Fire-fight	(19.4)	——	(67.5)
			Evacuate self	(13.1)	——	(74.1)

First Action	%	Second Action	%	Third Action	%
(c) Fire-fight	(13.2)	——		——	(17.7)
				——	(30.1)
		Contact FB	(22.7)	Fire-fight	(15.2)
				Minimise risk	(15.2)
(d) Alert others	(12.7)	Evacuate self	(17.4)	——	(67.6)
		Contact FB	(16.9)	Fire-fight	(21.2)
		Fire-fight	(13.8)	——	(51.9)
(e) Evacuate self	(11.1)	——		——	(59.1)
		Contact FB	(13.4)	——	(52.2)
(f) Minimise risk	(9.5)	Contact FB	(22.6)	Fire-fight	(24.2)
				-	(15.2)
		Fire-fight	(14.4)	Contact FB	(57.1)
		Minimise risk	(73.0)	Contact FB	(52.6)
		Alert others	(11.0)	Contact FB	(43.8)
(g) Evacuate others	(8.4)	Contact FB	(24.0)	——	(29.0)
				Fire-fight	(22.6)
		Minimise risk	(17.1)	Contact FB	(40.9)
		Fire-fight	(13.8)	——	(23.5)
				Contact FB	(17.6)
		Evacuate self	(9.3)	——	(50.0)

As with the trained sample discussed in the previous section, the actions of those with previous experience of fire appear to be more concentrated. In this case more than 40% choose to Investigate or Fire-fight as First Actions (29% for those with no previous experience). Fire-fighting seems generally more prevalent for the experienced sample, both in terms of First Action and as part of an action sequence. Whilst fire-fighting is also a frequent component of action sequences of the inexperienced, in each case a smaller percentage of individuals undertake it.

It is of interest that evacuating others does not appear in the list of First Actions of those with previous experience of fire, occurring as it does in less than 5% of the cases (4.4% to be exact). Evacuating oneself is also less frequent for this sample, the percentage of individuals choosing it as a First Action being almost half that of the inexperienced sample, for whom it also forms a component of an action sequence in several cases.

Whilst fire-fighting is more common for the experienced, contacting the Fire Brigade seems to be an over-riding concern of the inexperienced, comprising as it does the second most frequent First Action, with a larger percentage choosing it, and appearing very frequently in the action sequences. One point of similarity between the samples is that when fire-fighting is undertaken as the First Action, the subsequent action sequences are the same for both groups although the percentages differ.

We should further note that our previously experienced sample contains, as did the trained sample discussed earlier, action sequences in which investigating is undertaken subsequent to contacting the Fire Brigade and alerting others.

11.1.7 ACTION SEQUENCES IN RELATION TO THE PRESENCE OF OTHER PEOPLE

It will be recalled that we have separated our sample into three categories, one in which the person was alone in the building, a second in which family members were present, and a third category in which family members were not present. Whilst the latter two samples are large, the number of incidents in which only one person was in the building is relatively small, the number of interviewees comprising 11.1% of the total sample.

The action sequences for the 247 occupants interviewed who were alone in the building are presented below.

First Action	%	Second Action		Third Action	
(a) Contact FB	(20.6)	Evacuate self	(15.7)	——	(87.5)
		Investigate	(13.7)	——	(28.6)
		Increase risk	(13.7)	Fire-fight	(42.9)
		Fire-fight	(11.8)	——	(66.7)
(b) Fire-fight	(18.2)	Contact FB	(48.9)	——	(40.9)
		Fire-fight	(20.0)	Contact FB	(55.6)
		Minimise risk	(11.1)	Contact FB	(80.0)
(c) Minimise risk	(15.8)	Minimise risk	(25.6)	Contact FB	(90.0)
		Contact FB	(20.5)	Evacuate self	(31.0)
(d) Investigate	(9.5)	Fire-fight	(26.9)	Contact FB	(57.1)
		Minimise risk	(23.1)	Contact FB	(33.3)
(e) Evacuate self	(8.5)	——		——	(23.8)
		Contact FB	(33.3)	——	(57.1)
		Request assist	(19.0)	Contact FB	(50.0)
(f) Request assist	(5.8)	——		——	(75.0)

The action sequences for the 906 occupants interviewed who had members of their family present are presented below.

First Action	%	Second Action	%	Third Action	%
(a) Investigate	(17.2)	Contact FB	(19.0)	——	(33.3)
		Fire-fight	(15.2)	——	(41.7)
				Contact FB	(25.0)
		Minimise risk	(13.9)	Contact FB	(27.2)
				Fire-fight	(22.7)
(b) Evacuate others	(14.1)	——		——	(9.4)
		Contact FB	(25.8)	——	(30.3)
				Fire-fight	(26.7)
		Minimise risk	(17.2)	Contact FB	(45.5)
(c) Contact FB	(12.4)	Fire-fight	(24.1)	——	(70.4)
		Evacuate others	(14.3)	Evacuate self	(31.3)
(d) Alert others	(12.3)	Contact FB	(18.9)	——	(28.6)
		Evacuate others	(16.2)	——	(22.2)
		Evacuate self	(16.2)	——	(61.1)
(e) Minimise risk	(10.7)	Contact FB	(28.9)	Fire-fight	(25.0)
		Alert others	(13.4)	Contact FB	(46.2)
		Evacuate others	(11.3)	Contact FB	(36.4)
(f) Fire-fight	(10.1)	——		——	(14.1)
		Contact FB	(29.3)	——	(37.0)
(g) Evacuate self	(9.7)	——		——	(56.1)
		Contact FB	(19.5)	——	(50.0)

The action sequences for the 1040 occupants interviewed who did not have members of their family present are presented below.

First Action	%	Second Action	%	Third Action	%
(a) Investigate	(19.9)	Fire-fight	(32.4)	——	(68.7)
		Contact FB	(11.1)	Fire-fight	(30.4)
		Minimise risk	(11.1)	Fire-fight	(21.7)
(b) Fire-fight	(18.4)	——		——	(28.8)
		Contact FB	(15.2)	Fire-fight	
				Minimise risk	(27.6)
(c) Alert others	(15.6)	Fire-fight	(31.5)	——	(70.6)
		Evacuate self	(13.0)	——	(81.0)
		Investigate	(11.7)	Fire-fight	(36.8)
		——		——	(10.0)
(d) Contact FB	(11.7)	Fire-fight	(25.4)	——	(61.3)
		Alert others	(13.1)	——	(25.0)
		Evacuate self	(10.0)	——	(83.3)
(e) Evacuate self	(10.4)	——		——	(68.5)
(f) Minimise risk	(8.4)	——		——	(11.5)
		Fire-fight	(23.0)	——	(40.0)
				Contact FB	(35.0)
		Alert others	(13.8)	——	(33.3)

We can see large differences between these three samples, especially in terms of the First Actions. For the group alone in the building, we have the very unusual occurrence of investigating the fire being considerably less attractive than other actions, whilst contacting the Fire Brigade is a very frequent First Action. In contrast, where family members are present, fire-fighting is relatively infrequent as a First Action, whereas evacuating others assumes high importance. Exactly the reverse situation occurs when family members are not present, fire-fighting taking precedence whilst evacuating others is very infrequent (only 2.8% of the First Actions).

The case of people alone in the building is characterised by two further unusual actions, firstly we see that increasing the risk forms part of an action sequence, and secondly requesting assistance from others enters the behaviour patterns.

Having considered the effect which the selected Personal variables have upon the sequence of actions, we will now turn our attention to examining their influence upon three specific aspects of behaviour, namely evacuation of the building, returning into the building and movement through smoke.

11.2 EFFECT OF PERSONAL VARIABLES ON EVACUATION

More than 54% of the individuals interviewed in the Present Study left the building during the course of the fire. We have already seen that this type of behaviour was more prevalent in Dwellings than in other occupancies, and we now turn our attention to how these people differed from the 46% who did not leave.

11.2.1 EFFECT OF SEX AND AGE ON EVACUATION

The cross-tabulation of the sex of the person interviewed and whether or not they left the building is shown in Table 65 overleaf. It can be seen from the proportions in the table that women appear more likely to leave the building than men, and this is confirmed by the χ^2 test value ($\chi^2 =$ 31.8 (1 df), significant beyond the 0.001 level). We may thus confidently state that in the Present Study, women were more likely to leave the building during the course of the fire.

TABLE 65. Sex of interviewee by evacuation behaviour

Leave the building	Sex of interviewee		Total
	Female	Male	
Not leave	371 (36.9) (38.9)	634 (63.1) (51.1)	1005 (45.8)
Leave	582 (49.0) (61.1)	606 (51.0) (48.9)	1188 (54.2)
Total	953 (43.5)	1240 (56.5)	2193 (100.0)

As in earlier analyses of age, this has been broken down into eight categories. The percentage of people who left in each age group is shown in Figure 19. As might be expected, the under-10 year old age group has the modal value. The other striking feature is the apparent consistent decrease in the percentage of people leaving within each age range, right up to age 60. Thereafter the percentage again rises. These differences are statistically significant ($\chi^2 = 27.0$ (7 df), significant beyond the 0.001 level).

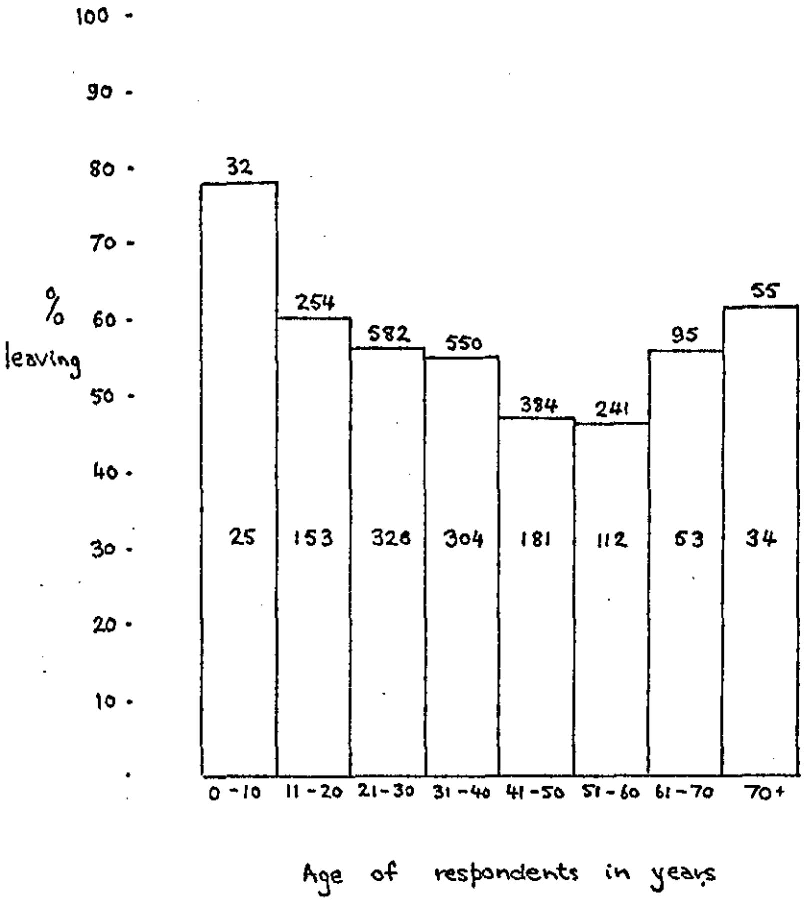
11.2.2 EFFECT OF SUBJECTIVE SERIOUSNESS RATING ON EVACUATION

It would seem intuitively reasonable that the more serious an individual considers a fire to be, the more likely that they will be to leave the building. This relationship is examined in Table 66 below.

TABLE 66. Seriousness rating by evacuation behaviour

Leave the building	Subjective seriousness rating			Total
	Not at all serious	Quite serious	Extremely serious	
Not leave	407 (40.5) (62.8)	475 (47.3) (43.0)	123 (12.2) (27.9)	1005 (45.8)
Leave	241 (20.3) (37.2)	629 (52.9) (57.0)	318 (26.8) (72.1)	1188 (54.2)
Total	648 (29.5)	1104 (50.3)	441 (20.1)	2193 (100.0)

Plainly, as the seriousness of the fire is subjectively judged to increase, the proportion of people who leave the building also increases. This clear relationship is confirmed by the χ^2 test ($\chi^2 = 135.9$ (2 df), significant beyond 0.001).



Numbers above each column are the total frequency in each age range. Numbers within each column are the number of people who left the building.

FIGURE 19. Percentage of respondants who left the building by age

11.2.3 EFFECT OF FAMILIARITY WITH THE BUILDING ON EVACUATION

It might be argued that individuals who are completely familiar with the building would be more likely to leave, simply because they will be aware of all the possible ways out. Alternatively it could be envisaged that unfamiliarity would act as a threat-increasing factor, which would lead to more frequent evacuation by this group. The cross-tabulation of familiarity with the building layout and evacuation is shown in Table 67 below.

TABLE 67. Familiarity with the building by evacuation behaviour

Leave the building	Familiarity with the building		Total
	Completely familiar	Less than completely	
Not Leave	835 (83.1) (44.8)	170 (16.9) (51.5)	1005 (45.8)
Leave	1028 (86.5) (55.2)	160 (13.5) (48.5)	1188 (54.2)
Total	1863 (85.0)	330 (15.0)	2193 (100.0)

The χ^2 value based upon the frequencies in Table 67 is 4.7 (1 df), which fails to reach the 0.01 level of probability. Thus both our hypotheses must be rejected, and we conclude that familiarity with the building has no effect upon whether or not people leave it.

11.2.4 EFFECT OF FREQUENCY OF TRAINING ON EVACUATION

Again we could postulate equally attractive alternative hypotheses. Firstly we might expect individuals who had received some training to be aware of the dangers, and thus to leave the building. On the other hand, those who are trained may be concerned with taking other actions, such as warning others and fire-fighting. The cross-tabulation of training frequency and whether or not an individual left the building is shown in Table 68 overleaf. Inspection of this table shows that a smaller proportion of people with training leave the building, an impression confirmed by the χ^2 test ($\chi^2 = 14.4$ (1 df), significant beyond 0.001).

TABLE 68. Frequency of training by evacuation behaviour

Leave the building	Training frequency		Total
	Never	Some training	
Not leave	759 (75.5) (43.7)	246 (24.5) (53.8)	1005 (45.8)
Leave	977 (82.2) (56.3)	211 (17.8) (46.2)	1188 (54.2)
Total	1736 (79.2)	457 (20.8)	2193 (100.0)

11.2.5 EFFECT OF PREVIOUS INVOLVEMENT IN A FIRE INCIDENT ON EVACUATION

Previous experience of fire might be considered to be a form of "one-trial" learning, in which case the same hypotheses as applied to the level of training would be relevant. We may see which is more likely from Table 69 below.

TABLE 69. Previous involvement in fire by evacuation behaviour

Leave the building	Previous involvement		Total
	No	Yes	
Not Leave	621 (61.8) (40.3)	384 (38.2) (58.8)	1005 (45.8)
Leave	919 (77.4) (59.7)	269 (22.6) (41.2)	1188 (54.2)
Total	1540 (70.2)	653 (29.8)	2193 (100.0)

As with the level of training, it appears from Table 69 that previous experience of fire reduces the likelihood of the individual leaving the building, as association confirmed by the χ^2 value of 62.3 (1 df), which is significant beyond the 0.001 level.

11.2.6 EFFECT OF THE PRESENCE OF OTHER PEOPLE IN THE BUILDING ON EVACUATION

As in earlier analyses we have categorised the presence of others under three headings, incidents where there was no-one else present in the building, incidents where family members were present, and incidents where there were no family members present. The cross-tabulation of these three against whether or not the individual left the building is shown in Table 70 overleaf.

TABLE 70. Presence of other people by evacuation behaviour

Leave the building	Others present			Total
	None	Family	Not family	
Not Leave	96 (9.6) (38.9	335 (33.3) (37.0)	574 (57.1) (55.2)	1005 (45.8)
Leave	151 (12.7) (61.1)	571 (48.1) (63.0)	466 (39.2) (44.8)	1188 (54.2)
Total	247 (11.3)	906 (41.3)	1040 (47.4)	2193 (100.0)

It can be seen that individuals who are alone in the building tend to leave just about as frequently as those in which family members are present, whereas when no family members are present, they leave less frequently. The expected values in the χ^2 calculation confirm this ($\chi^2 = 70.1$ (2 df), significant beyond the 0.001 level).

11.3 EFFECT OF PERSONAL VARIABLES ON RE-ENTRY BEHAVIOUR

Some 44% of those who left the building stated that they returned into it during the course of the fire. This behaviour is not related to the category of the building, although it is less common in buildings with large numbers of people. We will now examine the effect of our selected Personal variables upon its occurrence.

11.3.1 EFFECT OF SEX AND AGE ON RETURNING INTO THE BUILDING

The cross-tabulation of the sex of the person interviewed. against whether or not they returned into the building is shown in Table 71 which appears below.

TABLE 71. Sex of interviewee by re-entry behaviour

Return into the building	Sex of interviewee		Total
	Female	Male	
Not return	381 (57.3) (65.5)	284 (42.7) (46.9)	665 (56.0)
Return	201 (38.4) (34.5)	322 (61.6) (53.1)	523 (44.0)
Total	582 (49.0)	606 (51.0)	1188 (100.0)

On the evidence of Table 71, men appear to be more likely to return into the building than women, this observation being confirmed by the χ^2 test ($\chi^2 = 41.6$ (1 df), significant beyond the 0.001 level).

The percentage of people who returned into the building in each age group is illustrated in Figure 20. It will be noted that in the age range 21 to 50 years, there is a uniformly high percentage of people returning into the building. Leaving aside the youngest age group, there is however remarkably little difference between the groups. Overall there is no significant difference between the age groups in terms of re-entry behaviour ($\chi^2 = 14.9$ (7 df), non-significant).

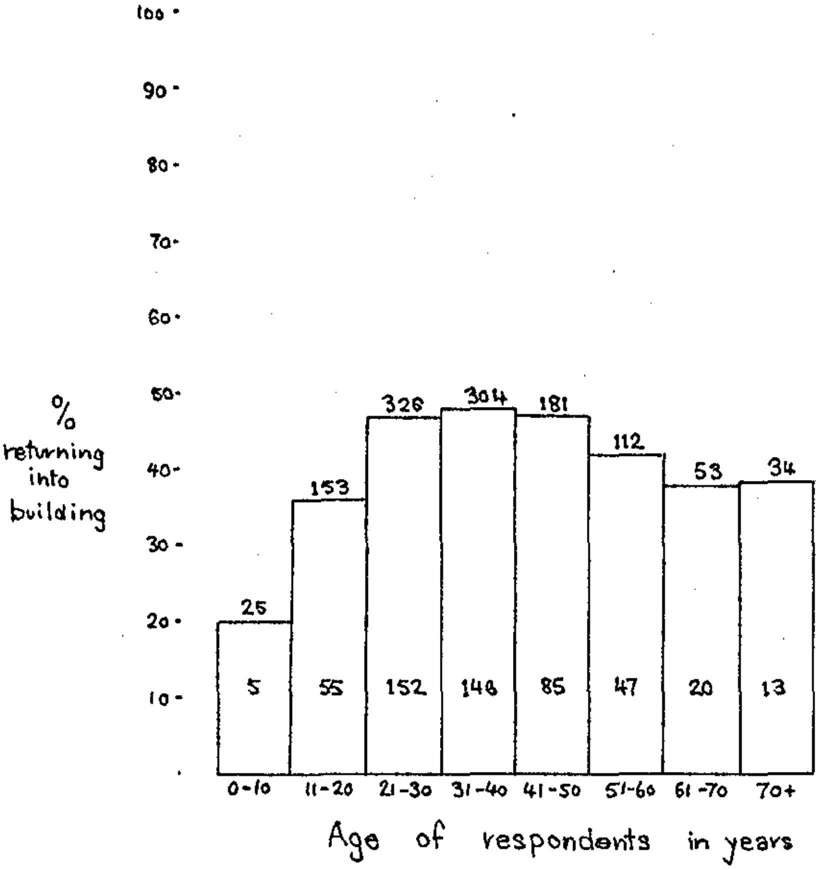
11.3.2 EFFECT OF SUBJECTIVE SERIOUSNESS RATING ON RE-ENTRY BEHAVIOUR

It would seem reasonable that the level of seriousness would be inversely related to re-entry behaviour. The cross-tabulation of how serious a person judged the fire to be and whether they returned into the building is shown in Table 72 below.

TABLE 72 . Seriousness rating by re-entry behaviour

Return into the building	Subjective seriousness rating			Total
	Not at all serious	Quite serious	Extremely serious	
Not return	121 (18.2) (50.2)	356 (53.5) (56.6)	188 (28.3) (59.1)	665 (56.0)
Return	120 (22.9) (49.8)	273 (52.2) (43.4)	130 (24.9) (40.9)	523 (44.0)
Total	241 (20.3)	629 (52.9)	318 (26.8)	1188 (100.0)

It can be seen that indeed, as was predicted, the percentage of people who return into the building falls consistently as the seriousness of the fire is judged to increase. However the differences between the categories are relatively small, and in fact overall the χ^2 value for Table 72 is non-significant ($\chi^2 = 4.6$ (2 df)). We must therefore conclude that the two variables are not associated. People return into the building irrespective of how serious they judge the fire to be.



Numbers above each column are the total number in each age range who left the building. Numbers within each column are the number of people who returned into the building.

FIGURE 20. Percentage of people who returned into the building by age

11.3.3 EFFECT OF FAMILIARITY WITH THE BUILDING ON RE-ENTRY BEHAVIOUR

We have seen that familiarity with the building does not affect whether or not an individual leaves the building. We would certainly predict that re-entry behaviour would be closely associated with complete familiarity with the building layout. The two variables are cross-tabulated in Table 73 below.

TABLE 73. Familiarity with the building by re-entry behaviour

Return into the building	Familiarity with the building		Total
	Completely familiar	Less than completely	
Not return	564 (84.8) (54.9)	101 (15.2) (63.1)	665 (56.0)
Return	464 (88.7) (45.1)	59 (11.3) (36.9)	523 (44.0)
Total	1028 (86.5)	160 (13.5)	1188 (100.0)

Inspection of Table 73 shows that a smaller percentage of individuals who are less than completely familiar with the building, re-enter it, however analysis reveals that this difference is not statistically significant ($\chi^2 = 3.8$ (1 df), non-significant). Thus people return into the building irrespective of how familiar they are with its layout.

11.3.4 EFFECT OF FREQUENCY OF TRAINING ON RE-ENTRY BEHAVIOUR

People who have received some training are less likely to leave the building as we have demonstrated. Since re-entering a building during a fire incident is generally not recommended, we would expect that people who had received some training would be less likely to undertake this behaviour. This relationship is illustrated in Table 74 overleaf. It can be seen from this table that the percentages for the two levels of training match exactly, implying absolutely no association, an impression borne out by a zero value of χ^2. We may thus state that the frequency of training for an individual does not affect whether or not they return into the building.

TABLE 74. Frequency of training by re-entry behaviour

Return into the building	Frequency of training		Total
	Never	Some	
Not return	547 (82.2) (56.0)	118 (17.8) (55.9)	665 (56.0)
Return	430 (82.2) (44.0)	93 (17.8) (44.1)	523 (44.0)
Total	977 (82.2)	211 (17.8)	1188 (100.0)

11.3.5 EFFECT OF PREVIOUS INVOLVEMENT IN A FIRE INCIDENT ON RE-ENTRY BEHAVIOUR

In considering evacuation behaviour we likened previous experience of fire to a form of training, and in this respect it was shown to have the same effect in reducing the number of people who leave. Were this similarity to be continued to re-entry behaviour we would expect, as in Section 11.3.4, re-entry behaviour to be independent of previous experience. The cross-tabulation of the two variables is shown in Table 75 below.

TABLE 75. Previous involvement in fire by re-entry behaviour

Return into the building	Previous involvement		Total
	No	Yes	
Not return	529 (79.5) (57.6)	136 (20.5) (50.6)	665 (56.0)
Return	390 (74.6) (42.4)	133 (25.4) (49.4)	523 (44.0)
Total	919 (77.4)	269 (22.6)	1188 (100.0)

It can be seen that a rather greater percentage of people with previous experience of fire return into the building, however the difference is not sufficiently large to make the relationship statistically significant ($\chi^2 = 4.1$ (1 df), non-significant). Previous experience of fire does not therefore appear to affect re-entry behaviour.

11.3.6 EFFECT OF THE PRESENCE OF OTHER PEOPLE ON RE-ENTRY BEHAVIOUR

Earlier analysis indicated that both people alone in the building and people with other family members present, are more likely to leave the building. For both these groups we would intuitively expect a lower level of returning into the building. The cross-tabulation is presented in Table 76 below.

TABLE 76 . Presence of other people by re-entry behaviour

Return into the building	Other present			Total
	None	Family	Not family	
Not return	80 (12.0) (53.0)	317 (47.7) (55.5)	268 (40.3) (57.5)	665 (56.0)
Return	71 (13.6) (47.0)	254 (48.6) (44.5)	198 (37.9) (42.5)	523 (44.0)
Total	151 (12.7)	571 (48.1)	466 (39.2)	1188 (100.0)

Contrary to our prediction, it is in fact the people alone and with other family members who show a greater percentage of re-entry behaviour, however the differences are small, and the association is not significant ($\chi^2 = 1.0$ (2 df), non-significant). Returning into the building is therefore not associated with the presence or absence of other people.

11.4 EFFECT OF PERSONAL VARIABLES ON MOVEMENT THROUGH SMOKE

Of the incidents in which smoke was present, almost 60% of the occupants interviewed stated that they attempted to move through it. We have seen that this type of behaviour appears to be less frequent in Industrial category buildings, although it is independent of the other building characteristics considered.

11.4.1 EFFECT OF SEX AND AGE ON MOVEMENT THROUGH SMOKE

The cross-tabulation of the sex of the person interviewed against whether or not they moved through smoke is shown in Table 77 overleaf. Inspection of this table suggests that men move more frequently through smoke than do women, this being confirmed by the χ^2 value of 21.5 (1 df), which is significant beyond the 0.001 level.

TABLE 77. Sex of interviewee by movement through smoke

Move through smoke	Sex of interviewee		Total
	Female	Male	
Not move	388 (50.5) (46.3)	381 (49.5) (35.8)	769 (40.4)
Move	450 (39.7) (53.7)	684 (60.3) (64.2)	1134 (59.6)
Total	838 (44.0)	1065 (56.0)	1903 (100.0)

The percentage of people who moved through smoke in each age group is shown in Figure 21 . Inspection of the figure shows that the percentages are remarkably similar overall, with only the under-10 and over-70 year old age groups departing at all substantially from other groups. Testing the frequencies on which these percentages are based gives a non-significant χ^2 value of 5.54 (7 df). It therefore appears that whether or not a person moved through smoke was unaffected by the age of the person.

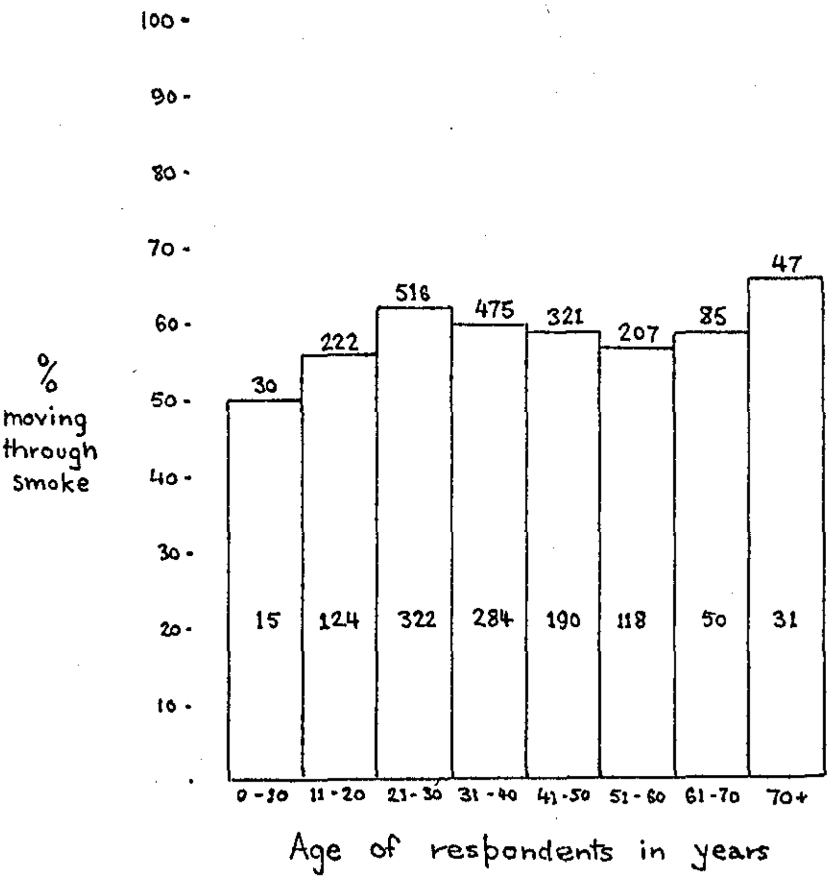
11.4.2 EFFECT OF SUBJECTIVE SERIOUSNESS RATING ON MOVEMENT THROUGH SMOKE

We would expect that the more serious a person perceived a fire to be, the less likely that they would attempt to move through smoke. The cross-tabulation of these two variables is shown in Table 78 below.

TABLE 78. Seriousness rating by movement through smoke

Move through smoke	Subjective seriousness rating			Total
	Not at all serious	Quite serious	Extremely serious	
Not move	231 (30.0) (43.1)	399 (51.9) (41.0)	139 (18.1) (35.2)	769 (40.4)
Move	305 (26.9) (56.9)	573 (50.5) (59.0)	256 (22.6) (64.8)	1134 (59.6)
Total	536 (28.2)	972 (51.1)	395 (20.8)	1903 (100.0)

Inspection of Table 78 indicates in fact that the opposite effect to that predicted, in that the proportion of people moving through smoke appears to increase with increased subjective seriousness. However this association is not statistically significant ($\chi^2 = 6.2$ (2 df)). Therefore



Numbers above each column are the total number of people in each age range who were present in incidents at which there was smoke. Numbers within each column are the number of people who moved through smoke.

FIGURE 21. Percentage of people who moved through smoke by age

movement through smoke is independent of the subjective seriousness rating of the fire.

11.4.3 EFFECT OF FAMILIARITY WITH THE BUILDING ON MOVEMENT THROUGH SMOKE

There are two potential hypotheses which could be generated concerning familiarity with the building. Firstly, it could be suggested that unfamiliarity with the building will be associated with increased threat, and therefore increased likelihood of movement through smoke. Alternatively, it might be argued that unfamiliarity with the building will be a potent reason for not moving through smoke. The cross-tabulation of the variables is presented in Table 79 below.

TABLE 79. Familiarity with the building by movement through smoke

Move through smoke	Familiarity with the building		Total
	Completely familiar	Less than completely	
Not move	632 (82.2) (39.0)	137 (17.8) (46.6)	769 (40.4)
Move	989 (87.2) (61.0)	145 (12.8) (51.4)	1134 (59.6)
Total	1621 (85.2)	282 (14.8)	1903 (100.0)

It can thus be seen from Table 79 that the proportions indicate that the latter hypothesis may be more likely, the association being substantiated by the χ^2 value of 9.2 (1 df), which is significant beyond the 0.01 level. People who are completely familiar with the building are more likely to move through smoke.

11.4.4 EFFECT OF FREQUENCY OF TRAINING ON MOVEMENT THROUGH SMOKE

It will be recalled from Chapter 10 that movement through smoke was shown to be less likely in Industrial category buildings. It was tentatively suggested that this association might reflect the generally higher levels of training frequency in this category of building, which would perhaps discourage this action. We many now directly test this hypothesis by cross-tabulating training frequency against movement through smoke in Table 80 overleaf.

TABLE 80. Frequency of training by movement through smoke

Move through smoke	Training frequency		Total
	Never	Some	
Not move	619 (80.5) (40.2)	150 (19.5) (41.1)	769 (40.4)
Move	919 (81.0) (59.8)	215 (19.6) (58.9)	1134 (59.6)
Total	1538 (80.8)	365 (19.2)	1903 (100.0)

The percentages in Table 80 show a remarkable homogenity, indicating that the variables are not associated. Testing reveals the expected low χ^2 value of 0.1 (1 df), which is non-significant. It is clear that movement through smoke is independent of training frequency, and furthermore differences in training frequency are therefore unlikely to be the reason for the low proportion of people moving through smoke in Industrial buildings.

11.4.5 EFFECT OF PREVIOUS INVOLVEMENT IN A FIRE INCIDENT ON MOVEMENT THROUGH SMOKE

In all our earlier analyses, previous involvement in a fire incident was shown to act exactly in the same manner as training frequency. On this basis we would expect that movement through smoke would be independent of previous involvement in a fire incident. The cross-tabulation is presented in Table 81 below.

TABLE 81. Previous involvement in a fire incident by movement through smoke

Move through smoke	Previous involvement		Total
	No	Yes	
Not move	559 (72.7) (41.1)	210 (27.3) (38.6)	769 (40.4)
Move	800 (70.5) (58.9)	334 (29.5) (61.4)	1134 (59.6)
Total	1359 (71.4)	544 (28.6)	1903 (100.0)

Again the percentages are very similar, suggesting that as predicted, previous involvement and movement through smoke are not associated, this lack of association being confirmed by the χ^2 value of 1.0 (1 df) which is non-significant. Previous experience of fire does not therefore appear to affect whether or not an individual moves through smoke.

11.4.6 EFFECT OF THE PRESENCE OF OTHER PEOPLE IN THE BUILDING ON MOVEMENT THROUGH SMOKE

In respect of leaving and returning into the building, people alone appear to behave in a similar fashion to people who have family members present, and differences which emerge being between these two groups and the group where family members are not present. We will examine to see if this trend continues regarding movement through smoke by means of Table 82 below.

TABLE 82. Presence of other people by movement through smoke

Move through smoke	Others present			Total
	None	Family	Not family	
Not move	81 (10.6) (36.3)	311 (40.4) (37.7)	377 (49.0) (44.1)	769 (40.4)
Move	142 (12.5) (63.7)	515 (45.4) (62.3)	477 (42.1) (55.9)	1134 (59.6)
Total	223 (11.7)	826 (43.4)	854 (44.9)	1903 (100.0)

As before, the percentage of people moving through smoke in the "None" and "Family" groups are very similar, whereas the "Not family" group has a somewhat lower percentage. Peforming the χ^2 test using the frequencies in Table 82 gives a value of 9.1 (2 df), which just fails to achieve the 0.01 level of significance. However since prior to commencing the analysis we had suggested that the "Not family" group might in fact behave differently to the others, we may validly partition the table to examine this relationship. Calculating χ^2 on this basis gives a value of 8.9 (1 df), which is significant beyond the 0.01 level. We may thus state that movement through smoke tends to be less likely when family members are not present, and more likely when individuals are alone or with other family members.

11.5 DISCUSSION

If we examine the action sequences across the range of Personal variables, we cannot fail to be struck by the seeming regularity with which certain patterns of behaviour recur. In almost every instance we have a limited series of initial actions which may be undertaken by a greater or lesser proportion of individuals, and which in turn are the precursors of a similarly limited range of behaviour patterns. It is only when we examine these sequences and the associated percentages in detail that we can see how they differ. One aspect which is not brought out explicitly in the analysis is the occasional absence of obvious behaviour patterns. Thus for example, where in the action sequences presented, a particular First Action is followed by other actions which are only pursued by relatively small percentages of people, then the actions of the remainder are, by implication, spread over such a wide range and at such low frequencies that no clear pattern emerges. As was indicated at the beginning of Chapter 9, the breakdowns only illustrate the most frequent action sequences. It would clearly be impractical to delineate the sequences exhaustively; however an indication of the variability of behaviour in any specific case is provided by the residual percentage for each successive combination of actions. Inspection suggests that this diversity of behaviour may be associated with particular First Actions, notably contacting the Fire Brigade and alerting others.

The differences which emerge from close study of the action sequences tend to suggest that some factors act consistently to increase the likelihood of particular courses of action. Thus fire-fighting is more common for men as opposed to women, trained as opposed to untrained, those with previous experience of fire as opposed to those without such experience, and the absence of family members. Similarly, concern with contacting the Fire Brigade appears to be more strongly associated with complete familiarity with the building, lack of training, inexperience of fire and the absence of other people in the building. One of the most revealing analyses concerns the effect of how serious the individual considers the fire to be, which clearly acts as a potent factor in determining what initial actions are undertaken. Perception of increased seriousness tends to increase the proportion of people who immediately evacuate themselves, evacuate others and alert others, and decrease the proportion who minimise the risk, fire-fight and investigate the fire.

Due to the often-ambiguous nature of the cues associated with fires, we would of course expect many people to investigate as a First Action. This is particularly the case for those who have received training, those with previous experience and in fires which are perceived as being "not at all serious". We are perhaps more interested when investigating the fire is not the most frequent First Action, or when it occurs subsequent to another action. The former event occurs when fires are judged to be "extremely" serious, and even more strikingly, when there are no other people present in the building. The latter behaviour pattern occurs in two basic forms. The action sequence

Contact FB → Investigate

is notable in building occupants aged 41 to 50 years, in those who are completely familiar with the building, those who have received some training, those with previous experience of fire and incidents in which the person is alone in the building. On the other hand, the sequence

Alert others → Investigate → Fire-fight

is restricted to trained people and those with previous experience, although a variation

Alert others → Contact FB → Investigate

can be noted in the sample of those aged 41 to 50 years. Plainly, behaviour patterns which incorporate such sequences must minimise the risk of casualties ensuing from the fire, although this comment would be even more valid, were the sequence

Evacuate others → Investigate

to be a common one.

Whilst similar sequences tend to reappear throughout the analyses, a number of unusual ones also occur in specific instances. Incidents in which no other people are present in the building appear to be rather special in this respect. We have already noted how investigating the fire occupies an unusual position in the hierarchy of actions for this group, and it is in addition remarkable in containing two other actions, requesting assistance and increasing the risk, which are uncommon. Other than in this sample, actions which increase the risk only appear in our illustrated sequences for two other groups, those aged 41 to 50 years, and where family members are present, whilst requesting assistance is otherwise only associated with fires judged to be "extremely serious".

Finally, we will consider how the Personal variables affect our three specific measures of behaviour. In terms of evacuation behaviour a number of clear associations emerge, factors which tend to increase the proportion leaving being absence of training, lack of previous experience and the absence of family members, as do increasing age up to 60 years and perception of increasing fire seriousness. In addition, women are more likely to leave the building than men.

Although a relatively large proportion of those who leave, return into the building during the course of the fire, this type of behaviour does not seem to be associated generally with differences in our Personal variables. Only in the case of sex, with men being more likely to re-enter than women, can we see an association.

Men were also more likely to move through smoke than women, as were people completely familiar with the building, and surprisingly, people alone in the building or where other family members were present. The first two associations seem intuitively plausible, and one can conceive the necessity for moving through smoke, to perhaps alert others, when family members are present; however undertaking this action when alone in the building appears to be most unwise.

CHAPTER 12

FIRE VARIABLES & BEHAVIOUR

12.0 FIRE VARIABLES AND BEHAVIOUR

It has been demonstrated earlier that there is no single measure which provides us with an adequate picture of the severity of the fire. When considering the effects of fire, we have in consequence utilised a number of measures, and we will continue with this practice in this chapter. The variables which will be examined are, the level of the Fire Severity Index (which it will be recalled, is a derived measure including all our Fire variables), the use or non-use of Jets, the extent of Smoke Spread, the density of the smoke and the time of the incident. For the analysis of behaviour patterns only, we have altered the classification of one of our variables, namely Smoke Density. This was originally categorised on a 7-point scale. However, when considering the breakdown of action sequences into such a relatively large number of categories, the frequencies in several categories are quite low. We have therefore dichotomised Smoke Density into "Low" and "High" levels at point 4 on the scale. Low density therefore includes scale-values 1 to 3, High density scale-values 4 to 7.

12.1 EFFECT OF FIRE VARIABLES ON PATTERNS OF BEHAVIOUR

As in earlier analyses, we have broken down the behaviour which individuals undertook into a series of action sequences. In each case, we illustrate the order and percentage of First Actions taken, the percentages for the Second and Third Actions representing the proportion of people who undertook this action, conditional upon the preceding action. As before, unless to illustrate a particular point, only the most frequent actions (i.e. those pursued by at least 5% of individuals) will be shown.

12.1.1 SEQUENCES OF ACTION IN RELATION TO LEVEL OF FIRE SEVERITY INDEX

Our original computation of the Fire Severity Index derived a scale with 44 points. This was subsequently revised to a 5-point scale, the categories being Very Low, Low, Medium, High and Very High FSI. The 5-point scale will be used for studying action sequences.

The most frequent action sequences undertaken by the 413 occupants interviewed in incidents classed as being "Very Low FSI" are shown overleaf.

First Action	%	Second Action	%	Third Action	%
(a) Minimise risk	(16.7)	Alert others	(20.2)	——	(30.8)
		Contact FB	(18.8)	——	(35.7)
(b) Investigate	(16.5)	Fire-fight	(22.1)	——	(46.7)
		Contact FB	(16.2)	——	(27.3)
		Minimise risk	(16.2)	——	(36.4)
(c) Contact FB	(16.2)	Fire-fight	(32.8)	——	(68.2)
(d) Fire-fight	(13.6)	——		——	(37.5)
		Contact FB	(30.3)	Fire-fight	(35.3)
				Minimise risk	(68.2)
(e) Alert others	(13.1)	Fire-fight	(32.8)	——	(68.2)

The most frequent action sequences undertaken by the 749 occupants interviewed in incidents classed as being "Low FSI" are shown below.

First Action	%	Second Action	%	Third Action	%
(a) Fire-fight	(19.0)	——		——	(31.7)
		Contact FB	(23.2)	——	(36.4)
				Fire-fight	(21.2)
(b) Investigate	(18.0)	Fire-fight	(31.1)	——	(61.9)
		Contact FB	(14.1)	——	(47.4)
(c) Contact FB	(11.2)	Fire-fight	(22.6)	——	(68.4)
(d) Alert others	(10.8)	Fire-fight	(32.1)	——	(73.1)
		Evacuate self	(13.6)		(72.7)
(e) Minimise risk	(10.8)	Fire-fight	(19.8)	——	(50.0)
		Contact FB	(18.5)		(20.0)
(f) Evacuate self	(9.3)	——		——	(52.8)
(g) Evacuate others	(6.9)	Contact FB	(21.2)	——	(36.3)

The most frequent action sequences undertaken by the 482 occupants interviewed in incidents classed as being "Medium FSI" are shown below.

First Action	%	Second Action	%	Third Action	%
(a) Investigate	(19.5)	Fire-fight	(19.1)	——	(72.2)
		Contact FB	(14.9)	——	(28.6)
		Minimise risk	(14.9)	——	(35.7)
(b) Contact FB	(13.7)	Fire-fight	(22.7)	——	(66.7)
(c) Fire-fight	(13.5)	——		——	(12.3)
		Contact FB	(21.5)	——	(42.8)
(d) Alert others	(12.9)	Evacuate self	(17.7)	——	(91.0)
		Contact FB	(16.1)	——	(22.7)
(e) Evacuate self	(10.4)	——		——	(66.0)
(f) Evacuate others	(8.7)	Fire-fight	(23.8)	Evacuate self	(30.0)
		Minimise risk	(21.4)	Contact FB	(66.7)
		Contact FB	(21.4)	——	(44.4)
(g) Minimise risk	(8.5)	Contact FB	(31.7)	Fire-fight	(46.2)
		Evacuate self	(17.1)	——	(57.1)

The most frequent action sequences undertaken by the 287 occupants interviewed in incidents classed as being "High FSI" are shown below.

First Action	%	Second Action	%	Third Action	%
(a) Investigate	(20.9)	→ Fire-fight	(28.3) →	——	(41.2)
		→ Minimise risk	(13.3) →	Contact FB	(37.5)
(b) Alert others	(16.7)	→ Fire-fight	(18.8) →	——	(33.3)
		→ Contact FB	(14.6) →	Evacuate self	(23.8)
(c) Contact FB	(13.2)	→ Fire-fight	(18.4) →	——	(57.1)
(d) Evacuate self	(12.9)	→ ——	→	——	(62.2)
(e) Fire-fight	(11.1)	→ Contact FB	(21.9) →	——	(28.6)
		→ ——	→	——	(15.6)
(f) Evacuate others	(7.3)	→ Contact FB	(23.8) →	——	(40.0)

The most frequent action sequences undertaken by the 262 occupants interviewed in incidents classed as being "Very High FSI" are shown below.

First Action	%	Second Action	%	Third Action	%
(a) Alert others	(14.5)	→ Evacuate self	(21.1) →	——	(62.5)
		→ Retreat from fire	(15.8) →	Request assist	(50.0)
(b) Investigate	(13.0)	→ Fire-fight	(17.6) →	——	(50.0)
		→ Contact FB	(15.6) →	——	(20.0)
(c) Evacuate self	(13.4)	→ ——	→	——	(54.3)
(d) Fire-fight	(12.6)	→ Evacuate self	(18.2) →	——	(25.0)
		→ ——	→	——	(27.2)
(e) Contact FB	(11.5)	→ Evacuate self	(20.0) →	——	(50.0)
		→ ——	→	——	(16.6)
(f) Evacuate others	(9.5)	→ Contact FB	(28.0) →	Evacuate self	(28.6)
		→ Evacuate self	(16.0) →	——	(50.0)
		→ Minimise risk	(16.0) →	——	(50.0)
(g) Minimise risk	(8.8)	→ Fire-fight	(27.2) →	——	(60.0)

We have noted in earlier analyses of behaviour patterns that a number of action sequences appear to be common to all breakdowns, and this is equally true with regard to the FSI level. Indeed we must be struck by how unaffected, with one or two notable exceptions, the action sequences are by differences in FSI level. The most obvious exception is the way in which evacuating oneself becomes an increasing component of the sequences as the fire becomes more severe. Another, though less clear-cut change relates to fire-fighting, which appears to reach a peak, in terms of both First Action and as an element of the action sequences, at Low levels of FSI.

If instead of action sequences we look at First Actions, a number of interesting points emerge. The first point is that the relative order of frequency is different for each level of FSI. Examining the order in which the First Actions are placed reveals that minimising the risk moves very rapidly down from being the most frequent First Action at Low FSI, to less than 5% at High FSI, although it recovers somewhat at Very High levels. In contrast, alerting others moves from a lowly fifth most frequent First Action at Low levels, to being the most frequent First Action at Very High levels, and similarly, evacuating oneself moves from seventh to third most frequent over the same range.

Examining the relative percentages rather than the order of First Actions is also of value. On this basis we find that contacting the Fire Brigade has its highest value at Very Low levels of FSI, whilst evacuating others has its lowest value at this level. The percentage undertaking fire-fighting as a First Action is substantially greater at Low FSI than any other level. High levels of FSI are characterised by the largest percentages investigating and alerting others, and the smallest percentages fire-fighting and minimising the risk. Finally the percentage who evacuate themselves increases consistently from Very Low to Very High levels of FSI. It thus appears that, except in the cases quoted, changes in fire severity as measured by FSI level may have more effect upon the frequency with which First Actions are chosen than the action sequences themselves.

12.1.2 SEQUENCES OF ACTION IN RELATION TO USE OF JETS

Of the 952 incidents, 269 required the use of one or more Jets to extinguish them, and 757 people were interviewed at such incidents, 34.5% of our total sample of respondants.

The most frequent action sequences undertaken by the 757 occupants interviewed at incidents which required one or more Jets are shown below.

First Action	%	Second Action	%	Third Action	%
(a) Investigate	(18.8)	Fire-fight	(29.5) →	——	(59.5)
		Contact FB	(12.7) →	Fire-fight	(44.4)
(b) Alert others	(15.9)	Fire-fight	(20.0) →	——	(50.0)
		Evacuate self	(19.2) →	——	(65.2)
		Contact FB	(15.0) →	——	(33.3)
(c) Fire-fight	(12.9)	——	→	——	(21.4)
		Contact FB	(18.3) →	——	(27.8)
		Evacuate self	(10.2) →	——	(50.0)

First Action	%	Second Action	%	Third Action	%
(d) Evacuate self	(12.7)	——		——	(60.4)
		Contact FB	(11.5)	——	(63.6)
(e) Contact FB	(11.8)	Fire-fight	(21.3)	——	(52.6)
		Investigate	(11.2)	Fire-fight	(40.0)
(f) Evacuate others	(7.0)	Contact FB	(28.2)	——	(33.3)
		Evacuate self	(13.2)	——	(71.4)
		Minimise risk	(13.2)	Contact FB	(28.5)
(g) Minimise risk	(5.9)	Fire-fight	(26.7)	——	(66.7)
		Contact FB	(17.8)	Fire-fight	(37.5)

The most frequent action sequences undertaken by the 1436 occupants interviewed at incidents which did not require Jets are shown below.

First Action	%	Second Action	%	Third Action	%
(a) Investigate	(17.3)	Fire-fight	(22.5)	——	(60.7)
				Contact FB	(16.7)
		Contact FB	(15.3)	——	(36.8)
				Minimise risk	(18.4)
		Minimise risk	(14.1)	——	(25.7)
				Fire-fight	(20.0)
				Contact FB	(20.0)
(b) Fire-fight	(16.0)	——		——	(29.1)
		Contact FB	(26.1)	——	(33.3)
				Fire-fight	(20.0)
				Minimise risk	(18.3)
(c) Contact FB	(13.6)	Fire-fight	(22.9)	——	(71.1)
(d) Minimise risk	(12.4)	Contact FB	(20.8)	Fire-fight	(24.3)
				——	(21.6)
		Alert others	(15.2)	Contact FB	(40.7)
				——	(22.2)
		Fire-fight	(14.0)	Contact FB	(44.0)
				——	(32.0)
		Minimise risk	(11.8)	Contact FB	(47.6)
(e) Alert others	(11.4)	Fire-fight	(23.3)	——	(73.6)
		Contact FB	(11.7)	——	(36.8)
		Evacuate self	(11.0)	——	(77.8)
(f) Evacuate self	(8.0)	——		——	(56.5)
		Contact FB	(16.5)	——	(42.1)
(g) Evacuate others	(7.3)	Contact FB	(21.0)	Fire-fight	(36.4)
				——	(22.7)
		Fire-fight	(17.1)	——	(27.8)
		Minimise risk	(16.2)	Contact FB	(47.1)
		Retreat fromfire	(9.5)	——	(90.0)

Inspection of the two sets of action sequences leads us to much the same conclusions as applied to the FSI level, namely that within the sequences the biggest differences are that evacuating oneself become much more frequent in severe incidents (i.e. when Jets are used) and minimising the risk also becomes a much less frequent element. In terms of First Actions, alerting others and evacuating oneself have substantially higher percentages in severe incidents, whereas minimising the risk has a substantially lower percentage.

12.1.3 SEQUENCES OF ACTION IN RELATION TO EXTENT OF SMOKE SPREAD

Smoke Spread was divided into five categories, Little or none, Confined to the room of origin, Confined to the floor of origin, Spread beyond the floor of origin, and Spread even more extensively.

The most frequent action sequences undertaken by the 257 occupants interviewed at incidents in which the Smoke Spread was little or none are shown below.

First Action	%	Second Action	%	Third Action	%
(a) Fire-fight	(19.4)	——		——	(42.0)
		Contact FB	(28.0)	Minimise risk	(35.7)
(b) Contact FB	(17.1)	Fire-fight	(36.4)	——	(87.5)
		Evacuate self	(13.6)	——	(83.3)
		Minimise risk	(13.6)	——	(50.0)
(c) Investigate	(16.3)	Fire-fight	(28.6)	——	(91.7)
		Contact FB	(14.3)	——	(50.0)
(d) Alert others	(16.3)	Fire-fight	(28.6)	——	(50.0)
		Investigate	(14.3)	——	(50.0)
(e) Minimise risk	(15.6)	Contact FB	(22.5)	Fire-fight	(33.3)
		Alert others	(15.0)	——	(33.3)
		Fire-fight	(15.0)	——	(50.0)
(f) Evacuate self	(5.1)	——		——	(46.2)

The most frequent action sequences undertaken by the 690 occupants interviewed at incidents in which the Smoke Spread was confined to the room of origin are shown below.

First Action	%	Second Action	%	Third Action	%
(a) Investigate	(16.8)	Fire-fight	(31.0)	——	(61.1)
		Contact FB	(15.5)	——	(33.3)
				Minimise risk	(22.2)
		Minimise risk	(19.7)	Contact FB	(29.4)
(b) Fire-fight	(15.3)	——		——	(27.1)
		Contact FB	(25.2)	——	(40.7)
(c) Minimise risk	(12.5)	Fire-fight	(18.6)	——	(43.8)
				Contact FB	(43.8)
		Alert others	(17.4)	Contact FB	(40.0)
		Contact FB	(16.3)	Evacuate others	(21.4)

First Action	%	Second Action	%	Third Action	%
(d) Contact FB	(12.0)	Fire-fight	(22.9)	——	(57.9)
		Investigate	(13.3)	Fire-fight	(45.5)
(e) Alert others	(10.9)	Fire-fight	(32.0)	——	(91.7)
		Contact FB	(10.7)	Evacuate others	(37.5)
		——		——	(10.0)
(f) Evacuate self	(10.0)	——		——	(58.0)
		Contact FB	(18.8)	——	(58.0)
(g) Evacuate others	(6.5)	Contact FB	(22.2)	——	(40.0)
		Minimise risk	(22.2)	Contact FB	(50.0)
		Fire-fight	(15.6)	——	(42.9)

The most frequent action sequences undertaken by the 618 occupants interviewed at incidents in which Smoke Spread was confined to the floor of origin are shown below.

First Action	%	Second Action	%	Third Action	%
(a) Investigate	(20.5)	Fire-fight	(25.2)	——	(50.0)
				Contact FB	(18.8)
		Contact FB	(13.4)	——	(41.2)
		Minimise risk	(12.6)	——	(31.3)
(b) Fire-fight	(14.7)	——		——	(22.0)
		Contact FB	(24.2)	——	(31.8)
(c) Contact FB	(13.3)	Fire-fight	(23.3)	——	(57.1)
		Minimise risk	(11.0)	——	(44.4)
		Evacuate others	(11.0)	Evacuate self	(44.4)
(d) Alert others	(11.8)	Fire-fight	(23.3)	——	(58.8)
		Evacuate self	(21.9)	——	(87.5)
		Evacuate others	(12.3)	Evacuate self	(22.2)
(e) Evacuate self	(10.2)	——		——	(58.7)
		Contact FB	(11.1)	——	(57.1)
(f) Evacuate others	(8.3)	Contact FB	(25.5)	——	(30.8)
		Fire-fight	(21.6)	——	(36.4)
(g) Minimise risk	(8.1)	Contact FB	(20.0)	——	(40.0)
		Alert others	(14.0)	Contact FB	(42.9)
		Fire-fight	(12.0)	Contact FB	(33.3)

The most frequent action sequences undertaken by the 445 occupants interviewed in which Smoke Spread went beyond the floor of origin are shown below.

First Action	%	Second Action	%	Third Action	%
(a) Investigate	(18.4)	Contact FB	(14.6)	Fire-fight	(33.3)
		Fire-fight	(14.6)	——	(50.0)
		Minimise risk	(14.6)	Contact FB	(25.0)
		——		Fire-fight	(25.0)
		——		——	(11.0)

First Action	%	Second Action	%	Third Action	%
(b) Alert others	(15.1)	Contact FB	(19.4)	Fire-fight	(30.8)
		Evacuate self	(13.4)	——	(77.8)
		Evacuate others	(13.4)	Evacuate self	(33.3)
(c) Fire-fight	(12.4)	——		——	(18.2)
		Contact FB	(20.0)	Minimise risk	(32.5)
(d) Contact FB	(12.1)	Investigate	(16.7)	Fire-fight	(44.4)
(e) Evacuate self	(11.0)	——		——	(61.2)
(f) Evacuate others	(9.0)	Minimise risk	(22.5)	Contact FB	(55.6)
		Contact FB	(20.0)	——	(37.5)
(g) Minimise risk	(8.3)	Contact FB	(27.0)	Fire-fight	(40.0)
		Fire-fight	(21.6)	——	(75.0)

The most frequent action sequences undertaken by the 183 occupants interviewed at incidents in which Smoke Spread was even more extensive are shown below.

First Action	%	Second Action	%	Third Action	%
(a) Alert others	(14.2)	Evacuate self	(19.2)	——	(40.0)
		Minimise risk	(15.4)	——	(50.0)
		Retreat from fire	(15.4)	Request assist	(75.0)
(b) Fire-fight	(13.7)	——		——	(16.0)
		Evacuate self	(20.0)	——	(40.0)
		Contact FB	(16.0)	——	(50.0)
(c) Investigate	(13.1)	Fire-fight	(25.0)	——	(66.7)
(d) Retreat from fire	(12.6)	Evacuate self	(69.6)	——	(87.5)
(e) Contact FB	(12.0)	Investigate	(18.2)	——	(50.0)
		Evacuate self	(18.2)	——	(75.0)
(f) Evacuate others	(9.8)	Contact FB	(27.8)	Evacuate self	(40.0)
		Evacuate self	(27.8)	——	(40.0)
(g) Evacuate self	(9.3)	——		——	(58.8)
(h) Minimise risk	(5.5)	Evacuate self	(20.0)	——	(100.0)

Again it is largely in the order and percentage of the First Actions that we can see differences in behaviour associated with the extent of Smoke Spread. The exceptions mainly relate to the highest level, when smoke spreads very extensively. In this case it is clear that evacuating oneself becomes a very frequent component of the action sequences, and in addition we have for the first time, sequences which incorporate a substantial proportion of people who retreat from the fire.

Otherwise we should note that the biggest percentages for fire-fighting, contacting the Fire Brigade, alerting others and minimising the risk, as First Actions, all occur at the lowest level of Smoke Spread.

Both fire-fighting and minimising the risk show a virtually consistent decline in percentage as the extent of Smoke Spread increases, and whilst alerting others also declines in frequency, if we instead examine the order of First Actions, we find it moves to become the most frequent First Action when smoke spreads very extensively. In addition it can be seen that the percentage of individuals who elect to evacuate themselves, and evacuate others, rises as smoke spreads more extensively.

12.1.4 SEQUENCES OF ACTION IN RELATION TO DENSITY OF THE SMOKE

As was discussed in Section 12.0, we have recategorised Smoke Density into two levels, "Low" and "High".

The most frequent action sequences undertaken by the 1402 occupants interviewed at incidents in which Smoke Density was Low are shown below.

First Action	%	Second Action	%	Third Action	%
(a) Investigate	(18.3)	Fire-fight	(24.9)	——	(68.8)
				Contact FB	(14.4)
		Contact FB	(13.6)	——	(37.1)
				Minimise risk	(17.1)
		Minimise risk	(13.2)	——	(29.4)
				Fire-fight	(20.6)
		——		——	(9.7)
(b) Fire-fight	(15.8)	——		——	(31.5)
		Contact FB	(24.3)	——	(33.3)
				Fire-fight	(22.2)
				Minimise risk	(20.4)
(c) Contact FB	(13.0)	Fire-fight	(25.3)	——	(69.6)
		Investigate	(12.6)	——	(34.8)
		Minimise risk	(10.4)	——	(47.4)
		Something else *	(21.6)	——	(60.9)
(d) Alert others	(13.0)	Fire-fight	(23.1)	——	(64.3)
				Contact FB	(16.6)
		Evacuate self	(13.7)	——	(76.0)
		Contact FB	(12.1)	——	(60.9)
		Investigate	(10.4)	——	(31.5)
		——		——	(9.9)
(e) Minimise risk	(11.1)	Contact FB	(21.2)	Fire-fight	(30.3)
		Fire-fight	(15.4)	Contact FB	(41.7)
		Alert others	(14.1)	Contact FB	(36.4)
		Minimise risk	(11.5)	Contact FB	(44.4)
(f) Evacuate self	(9.1)	——		——	(51.2)
		Contact FB	(14.2)	——	(33.3)

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* Most often saving personal effects

	First Action	%	Second Action	%	Third Action	%
(g)	Evacuate others	(5.9)	Contact FB	(22.9)	Fire-fight	(42.1)
			Fire-fight	(19.3)	——	(25.0)
					Contact FB	(25.0)
			Minimise risk	(12.0)	Contact FB	(30.0)

The most frequent action sequences undertaken by the 791 occupants interviewed at incidents in which Smoke Density was High are shown below.

	First Action	%	Second Action	%	Third Action	%
(a)	Investigate	(16.9)	Fire-fight	(25.4)	——	(50.0)
			Contact FB	(15.7)	Fire-fight	(28.6)
			Minimise risk	(12.7)	Contact FB	(35.3)
			Evacuate others	(10.4)	Fire-fight	(28.6)
(b)	Fire-fight	(13.4)	-		——	(16.0)
			Contact FB	(22.6)	——	(29.2)
			Evacuate self	(12.3)	——	(46.2)
(c)	Contact FB	(13.0)	Fire-fight	(17.5)	——	(55.5)
			Evacuate self	(12.6)	——	(76.9
			Investigate	(9.7)	Fire-fight	(40.0)
			Render assist	(9.7)	——	(40.0)
(d)	Alert others	(12.8)	Fire-fight	(19.8)	——	(65.0)
			Evacuate self	(15.8)	——	(62.5)
			Contact FB	(14.9)	——	(26.7)
			Evacuate others	(11.9)	Contact FB	(33.3)
(e)	Evacuate self	(10.6)	-		——	(58.3)
			Contact FB	(14.3)	——	(75.0)
			Request assist	(9.5)	——	(50.0)
(f)	Evacuate others	(9.5)	Contact FB	(24.0)	——	(27.8)
			Minimise risk	(18.7)	Contact FB	(50.0)
			Evacuate self	(12.0)	——	(44.4)
(g)	Minimise risk	(8.5)	Fire-fight	(19.4)	——	(53.8)
			Contact FB	(17.9)	Evacuate self	(41.7)
			Evacuate self	(11.9)	——	(75.0)

Inspecting the two sets of action sequences reveals that, in this case, the percentages and orders of the majority of First Actions are remarkably similar. The only exception to this is the very much larger proportion who evacuate others when Smoke Density is High.

With respect to the action sequences, it can be seen that contacting the Fire Brigade is a very frequent component at Low Smoke Density, whereas evacuating oneself is a relatively common element at High density.

12.1.5 SEQUENCES OF ACTION IN RELATION TO TIME OF THE INCIDENT

Our sample of incidents was classified into those which occurred during the Day (0600 to 1959), and those which occurred at Night (2000 to 0559).

The most frequent action sequences undertaken by the 1770 occupants interviewed at incidents which occurred in the day are shown below.

First Action	%	Second Action	%	Third Action	%
(a) Investigate	(17.5)	Fire-fight	(26.9)	——	(62.7)
		Contact FB	(13.9)	——	(25.6)
				Contact FB	(23.3)
		Minimise risk	(12.6)	——	(30.8)
				Contact FB	(21.6)
(b) Fire-fight	(15.6)	——		——	(23.2)
		Contact FB	(23.6)	——	(33.8)
				Minimise risk	(21.5)
				Fire-fight	(20.0)
(c) Contact FB	(14.2)	Fire-fight	(22.7)	——	(63.2)
		Investigate	(12.4)	Fire-fight	(35.4)
		Evacuate self	(9.2)	——	(78.3)
(d) Alert others	(11.8)	Fire-fight	(23.0)	——	(62.5)
		Evacuate self	(16.3)	——	(75.5)
		Contact FB	(13.0)	——	(22.2)
(e) Minimise risk	(10.4)	Contact FB	(21.2)	Fire-fight	(25.6)
		Alert others	(13.6)	Contact FB	(36.0)
		Fire-fight	(13.6)	Contact FB	(44.0)
(f) Evacuate self	(9.5)	——		——	(55.6)
		Contact FB	(17.2)	——	(51.7)
(g) Evacuate others	(7.0)	Contact FB	(24.2)	Fire-fight	(30.0)
				——	(26.7)
		Minimise risk	(16.9)	Contact FB	(42.9)

The most frequent action sequences undertaken by the 423 occupants interviewed at incidents which occurred in the night are shown below.

First Action	%	Second Action	%	Third Action	%
(a) Investigate	(19.4)	Fire-fight	(18.3)	——	(46.7)
		Contact FB	(15.6)	——	(38.5)
		Minimise risk	(14.6)	Contact FB	(33.3)
				Fire-fight	(33.3)
(b) Alert others	(17.7)	Fire-fight	(18.6)	——	(71.4)
		Contact FB	(13.3)	——	(30.0)
		Evacuate others	(10.7)	——	(57.1)
(c) Fire-fight	(12.3)	——		——	(25.0)
		Contact FB	(25.0)	——	(23.1)
(d) Evacuate self	(9.9)	——		——	(69.0)
(e) Minimise risk	(9.2)	Fire-fight	(30.8)	——	(58.3)
(f) Contact FB	(8.0)	Fire-fight	(20.6)	——	(85.7)
(g) Evacuate others	(8.0)	Contact FB	(20.6)	——	(28.5)
		Fire-fight	(20.6)	——	(42.9)
		——		——	

The most important differences in behaviour related to the time of the incident are that in night-time incidents individuals are much less likely to contact the Fire Brigade and much more likely to alert others. They also appear to be rather less likely to fire-fight at night-time. Surprisingly there is very little difference in percentages for those who evacuate themselves, or others, although evacuating oneself does appear within the action sequences of daytime incidents. It is interesting that in the daytime incidents we have an example of the

Contact FB ⟶ Investigate

type sequence, but not at night, although we would have thought it more appropriate under night-time circumstances.

We will now move from considering overall behaviour patterns to the specific actions of leaving the building, re-entering the building and moving through smoke.

12.2 EFFECT OF FIRE VARIABLES ON EVACUATION BEHAVIOUR

With the exception of the time of the incident, each of our variables is related in some respect to the severity of the fire. It would seem natural that as these variables increased (i.e. as the fire became more severe), we would expect more people to leave the building during the course of the fire, since increased severity must be perceived as increased threat. With respect to the time of the incident our hypothesis is less obvious, as although a night-time fire must be a more stressful experience, the practical aspects would favour more people leaving during the day. We will consider the effects of each of our Fire variables on evacuation behaviour in turn.

12.2.1 EFFECT OF LEVEL OF FIRE SEVERITY INDEX ON EVACUATION BEHAVIOUR

As in earlier analyses, we will consider evacuation behaviour in two ways. Firstly, by examining the number of individuals who left the building from our sample of 2193 interviewees, and secondly, by analysing the proportion of people who left each building from our sample of 952 incidents (see Section 10.1.2 (p.166) for a fuller explanation).

The cross-tabulation of whether or not an individual left the building during the course of the fire against the level of FSI is shown in Table 83 overleaf. It is obvious from study of this table that an increasing percentage of individuals leave the building as the level of FSI increases. The reality of this association is confirmed by the significant χ^2 value of 251.4 (4 df), which is significant beyond the 0.001 level.

As in almost 80% of the 952 incidents either all the occupants left the building or none of them left, we have broken the proportion of people who left into five categories, as in earlier analyses of this type. The cross-tabulation of the proportion leaving each incident against FSI level is shown in Table 84 overleaf.

The evidence from the incidents presented in Table 84 reinforces our earlier finding when considering the behaviour of individuals. In this case we can see that there is a consistent fall in the percentage of incidents in which no-one left, and a corresponding rise in the percentage of incidents in which everyone left, as the FSI level increases. The χ^2 value based on the frequencies given in Table 84 is 134.5 (16 df), which is significant beyond the 0.001 level. We may thus state that the more severe the fire, the more likely it is that people will leave the building.

12.2.2 EFFECT OF USE OR NON-USE OF JETS ON EVACUATION BEHAVIOUR

As the use of Jets to extinguish a fire indicates a more severe incident, we would predict that a greater proportion of people would leave the building under these increased threat conditions. The cross-tabulation of the use of Jets against whether or not an individual left the building during the course of the incident is shown in Table 85 (p. 230). Inspection of this table shows that a considerably greater percentage of people left incidents in which Jets were used, and the statistical significance of this relationship is confirmed by the χ^2 test ($\chi^2 = 56.5$ (1 df), significant beyond the 0.001 level). Individuals are therefore more likely to leave the building if Jets are used.

TABLE 83. Level of FSI by evacuation behaviour

Leave the building	FSI level					Total
	Very Low	Low	Medium	High	Very High	
Not Leave	288 (28.7) (69.7)	410 (40.8) (54.7)	168 (16.7) (34.9)	96 (9.6) (33.4)	43 (4.3) (16.4)	1005 (45.8)
Leave	125 (10.5) (30.3)	339 (28.5) (45.3)	314 (26.4) (65.1)	191 (16.1) (66.6)	219 (18.4) (83.6)	1188 (54.2)
Total	413 (18.8)	749 (34.2)	482 (22.0)	287 (13.1)	262 (11.9)	2193 (100.0)

TABLE 84. Level of FSI by proportion of people leaving the building

Proportion leaving	FSI level					Total
	Very Low	Low	Medium	High	Very High	
0%	112 (38.0) (56.6)	112 (38.0) (33.5)	46 (15.6) (20.7)	22 (7.5) (21.0)	3 (1.0) (3.2)	295 (31.0)
1% to 30%	8 (14.0) (4.6)	24 (42.1) (7.2)	19 (33.3) (8.6)	3 (5.3) (2.9)	3 (5.3) (3.2)	57 (6.0)
31% to 70%	19 (20.2) (9.6)	38 (40.4) (11.4)	18 (19.1) (8.1)	9 (9.6) (8.6)	10 (10.6) (10.8)	94 (9.9)
71% to 99%	4 (9.5) (2.0)	18 (42.9) (5.4)	10 (23.8) (4.5)	6 (14.3) (5.7)	4 (9.5) (4.3)	42 (4.4)
100%	55 (11.9) (27.8)	142 (30.6) (42.5)	129 (27.8) (58.1)	65 (14.0) (61.9)	73 (15.7) (78.5)	464 (48.7)
Total	198 (20.8)	334 (35.1)	222 (23.3)	105 (11.0)	93 (9.8)	952 (100.0)

TABLE 85. Use of Jets by evacuation behaviour

Leave the building	Use of Jets		Total
	Not Used	Used	
Not leave	742 (73.8) (51.7)	263 (26.2) (34.7)	1005 (45.8)
Leave	694 (58.4) (48.3)	494 (41.6) (65.3)	1188 (54.2)
Total	1436 (65.5)	757 (34.5)	2193 (100.0)

The cross-tabulation of the proportion of people who left the building against the use of Jets is shown in Table 86 overleaf. Again is is in the 0% and 100% categories where we see the most obvious discrepancies, it being clear that when Jets are used there are, respectively, disproportionately fewer and disproportionately more people in those groups ($\chi^2 = 26.8$ (4 df), significant beyond 0.001).

12.2.3 EFFECT OF SMOKE SPREAD ON EVACUATION BEHAVIOUR

The cross-tabulation of the extent of Smoke Spread against whether or not individuals left the building during the course of the fire is shown in Table 87 (p.232). Examination of this table shows clearly that the percentage of individuals leaving the building increases consistently with increasing Smoke Spread. This trend is confirmed by the χ^2 value of 161.7 (4 df), which is significant beyond 0.001. The more extensive the Smoke Spread, the more likely it is that an individual will leave the building.

Since it is obvious from the previous two analyses of evacuation from incidents that the biggest differences are manifest in the 0% and 100% groups, we have, when considering Smoke Spread and Smoke Density, reduced our categories of "proportion leaving" to three, namely 0%, 1% to 99% and 100%. The cross-tabulation of the proportion of people who left, categorised in the above way, against the extent of Smoke Spread is shown in Table 88 (p.232). The consistent trends readily observable in this table, and the χ^2 value of 80.6 (8 df), which is significant beyond the 0.001 level, confirm our earlier finding of individual evacuation behaviour, namely that the proportion leaving will increase with increasing Smoke Spread.

TABLE 86. Use of Jets by proportion of people leaving the building

Use of Jets	Proportion leaving each incident					Total
	0%	1% to 30%	31% to 70%	71% to 99%	100%	
Not used	244 (35.8) (82.7)	39 (5.7) (68.4)	65 (9.5) (69.1)	28 (4.1) (66.7)	305 (44.8) (65.7)	681 (71.5)
Used	51 (18.8) (17.3)	18 (6.6) (31.6)	29 (10.7) (30.9)	14 (5.2) (33.3)	159 (58.7) (34.3)	271 (28.5)
Total	295 (31.0)	57 (6.0)	94 (9.9)	42 (4.4)	464 (48.7)	952 (100.0)

TABLE 87. Extent of Smoke Spread by evacuation behaviour

Leave the building	Extent of Smoke Spread					Total
	Little or none	Confined to room of origin	Confined to floor of origin	Spread to floor above	Even more extensive	
Not leave	177 (17.6) (68.9)	392 (39.0) (56.8)	236 (23.5) (38.2)	159 (15.8) (35.7)	41 (4.1) (22.4)	1005 (45.8)
Leave	80 (6.7) (31.1)	298 (25.1) (43.2)	382 (32.2) (61.8)	286 (24.1) (64.3)	142 (12.0) (77.6)	1188 (54.2)
Total	257 (11.7)	690 (31.5)	618 (28.2)	445 (20.3)	183 (8.3)	2193 (100.0)

TABLE 88. Extent of Smoke Spread by proportion of people leaving

Proportion leaving each incident	Extent of Smoke Spread					Total
	Little or none	Confined to room of origin	Confined to floor of origin	Spread to floor above	Even more extensive	
0%	66 (22.4) (57.9)	120 (40.7) (37.4)	66 (22.4) (25.6)	39 (13.2) (19.4)	4 (1.4) (6.9)	295 (31.0)
1% to 99%	16 (8.3) (14.0)	67 (34.7) (20.9)	56 (29.0) (21.7)	40 (20.7) (19.9)	14 (7.3) (24.1)	193 (20.3)
100%	32 (6.9) (28.1)	134 (28.9) (41.7)	136 (29.3) (52.7)	122 (26.3) (60.7)	40 (8.6) (69.0)	464 (48.7)
Total	114 (12.0)	321 (33.7)	258 (27.1)	201 (21.1)	58 (6.1)	952 (100.0)

12.2.4 EFFECT OF SMOKE DENSITY ON EVACUATION BEHAVIOUR

The cross-tabulation of the density of the smoke against whether or not individuals left the building during the course of the fire is shown in Table 89 overleaf. Although the consistency is not absolute, as it was in the case of Smoke Spread, it can be seen from this table that up to scale-value 5 there is a steady increase in the percentage of individuals leaving, at which point the relative frequency of leaving evens out. This association is established by the χ^2 value of 239.9 (6 df), which is significant beyond the 0.001 level.

The cross-tabulation of the proportion of people leaving each incident against the density of the smoke is shown in Table 90 overleaf. Examination of this table indicates that the general trend is for an increasing number of incidents to have a greater proportion of people leave as Smoke Density increases. This association is confirmed by the χ^2 value of 114.9 (12 df), which is significant beyond the 0.001 level.

12.2.5 EFFECT OF TIME OF DAY ON EVACUATION BEHAVIOUR

The time at which the incident occurred was categorised as follows: daytime (0600 to 2159), night-time (2150 to 0559). The cross-tabulation of the time of the incident against whether or not individuals left the building during the course of the fire is shown in Table 91 below.

TABLE 91. Time of the incident by evacuation behaviour

Leave the building	Time of incident		Total
	Day	Night	
Not Leave	848 (84.4) (47.9)	157 (15.6) (37.1)	1005 (45.8)
Leave	922 (77.6) (52.1)	266 (22.4) (62.9)	1188 (54.2)
Total	1770 (80.7)	423 (19.3)	2193 (100.0)

It can be seen from Table 91 above that a considerably greater percentage of individuals appear to leave the building during night-time incidents. This relationship is confirmed by the χ^2 value of 15.5 (1 df), which is significant beyond the 0.001 level.

TABLE 89. Smoke Density by evacuation behaviour

Leave the building	Smoke Density scale-values							Total
	1	2	3	4	5	6	7	
Not leave	442 (44.0) (67.4)	161 (16.0) (51.3)	171 (17.0) (39.6)	134 (13.3) (37.6)	54 (5.4) (22.0)	26 (2.6) (23.0)	17 (1.7) (22.4)	1005 (45.8)
Leave	214 (18.0) (32.6)	153 (12.9) (48.7)	261 (22.0) (60.4)	222 (18.7) (62.4)	192 (16.2) (78.0)	87 (7.3) (77.0)	59 (5.0) (77.6)	1188 (54.2)
Total	656 (29.9)	314 (14.3)	432 (19.7)	356 (16.2)	246 (11.2)	113 (5.2)	76 (3.5)	2193 (100.0)

TABLE 90. Smoke Density by proportion of people leaving

Proportion leaving	Smoke Density scale-values							Total
	1	2	3	4	5	6	7	
0%	153 (51.9) (51.3)	48 (16.3) (31.6)	32 (10.8) (18.8)	33 (11.2) (22.9)	17 (5.8) (15.7)	7 (2.4) (14.3)	5 (1.7) (16.1)	295 (31.0)
1% to 99%	57 (29.5) (19.1)	32 (16.6) (21.0)	47 (24.4) (27.6)	28 (14.5) (19.4)	16 (8.3) (14.8)	9 (4.7) (18.4)	4 (2.1) (12.9)	193 (20.3)
100%	88 (19.0) (29.5)	72 (15.5) (47.4)	91 (19.6) (53.5)	83 (17.9) (57.6)	75 (16.2) (69.4)	33 (7.1) (67.3)	22 (4.7) (71.0)	464 (48.7)
Total	298 (31.3)	152 (16.0)	170 (17.9)	144 (15.1)	108 (11.3)	49 (5.1)	31 (3.3)	952 (100.0)

The cross-tabulation of the proportion of people leaving each incident against the time of the incident is shown in Table 92 overleaf. Inspection of this table suggests that there is little difference in the proportions leaving between night-time and daytime incidents, and this impression is confirmed by the χ^2 value of 1.5 (4 df), which is non-significant. Therefore the proportion of people who leave at each incident is unaffected by the time it takes place.

12.3 EFFECT OF FIRE VARIABLES ON RETURNING INTO THE BUILDING

As a general hypothesis, it would seem reasonable that individuals would be less likely to return into buildings if the fire was more severe. We would also suggest that people would be less inclined to re-enter the building if the incident occurred at night.

12.3.1 EFFECT OF LEVEL OF FIRE SEVERITY INDEX ON RE-ENTRY BEHAVIOUR

The cross-tabulation of whether or not an individual returned into the building during the course of the incident against the level of FSI is shown in Table 93 overleaf. It can be seen from this table that progressively fewer people re-enter the building as the level of FSI increases. This trend is confirmed by the χ^2 test ($\chi^2 = 16.56$ (4 df), significant beyond 0.001). Thus using FSI as our measure, the more severe the fire proves to be, the less likely it is that people will return into the building.

12.3.2 EFFECT OF USE OR NON-USE OF JETS ON RE-ENTRY BEHAVIOUR

The cross-tabulation of whether or not an individual returned into the building during the course of the incident against whether Jets were used is shown in Table 94 below.

TABLE 94. Use of Jets by re-entry behaviour

Return into the building	Use of Jets		Total
	Not Used	Used	
Not used	374 (56.2) (53.9)	291 (43.8) (58.9)	665 (56.0)
Used	320 (61.2) (46.1)	203 (38.8) (41.1)	523 (44.0)
Total	694 (58.4)	494 (41.6)	1188 (100.0)

TABLE 92. Time by proportion of people leaving

Time	Proportion leaving each incident					Total
	0%	1% to 30%	31% to 70%	71% to 99%	100%	
Day	237 (30.5) (80.3)	48 (6.2) (84.2)	74 (9.5) (78.7)	35 (4.5) (83.3)	385 (49.4) (82.8)	778 (81.7)
Night	58 (33.3) (19.7)	9 (5.2) (15.8)	20 (11.5) (21.3)	7 (4.0) (16.7)	80 (46.0) (17.2)	174 (18.3)
Total	295 (31.0)	57 (6.0)	94 (9.9)	42 (4.4)	464 (48.7)	952 (100.0)

TABLE 93. Level of FSI by re-entry behaviour

Return into the building	FSI level					Total
	Very Low	Low	Medium	High	Very High	
Not return	54 (8.1) (43.2)	178 (26.8) (52.5)	178 (26.8) (56.7)	117 (17.6) (61.3)	138 (20.8) (63.0)	665 (56.0)
Return	71 (13.6) (56.8)	161 (30.8) (47.5)	136 (26.0) (43.3)	74 (14.1) (38.7)	81 (15.5) (37.0)	523 (44.0)
Total	125 (10.5)	339 (28.5)	314 (26.4)	191 (16.1)	219 (18.4)	1188 (100.0)

Inspection of Table 94 shows that although the percentage of people returning into the building is less at incidents when Jets are used, the difference in this case is relatively small, and is statistically non-significant ($\chi^2 = 2.9$ (1 df). Therefore using Jets as our measure, we can state that re-entry behaviour is independent of fire severity.

12.3.3 EFFECT OF SMOKE SPREAD ON RE-ENTRY BEHAVIOUR

The cross-tabulation of the extent of Smoke Spread against whether or not an individual returned into the building during the course of the incident is shown in Table 95 overleaf. Examination of this table reveals that the general trend is for the percentage of people returning into the building to reduce as the smoke spreads more extensively, although not with absolute consistency. The χ^2 value calculated from the frequencies in Table 95 gives a value which exceeds the 1% level of probability ($\chi^2 = 17.1$ (4 df), significant beyond 0.001).

12.3.4 EFFECT OF SMOKE DENSITY ON RE-ENTRY BEHAVIOUR

The cross-tabulation of the density of the smoke against whether or not an individual returned into the building during the course of the incident is shown in Table 96 overleaf. Performing the χ^2 test on the frequencies given in this table yields a value of 23.0 (6 df), which is significant beyond the 0.001 level. It will be noted that the percentage of individuals re-entering the building falls steadily up to scale-value 5, at which point it increases again. There is no obvious explanation for this sudden reversal.

12.3.5 EFFECT OF TIME OF DAY ON RE-ENTRY BEHAVIOUR

Since we would hypothesise that the stressful effects of a fire incident would be exacerbated during a night-time incident, we would predict that people would be less likely to re-enter the building at night. The cross-tabulation of the time of the incident against whether or not individuals returned into the building is shown in Table 97 (p.239). It is clear from the evidence of this table that there is very little difference in re-entry behaviour during day and night incidents. This impression is confirmed the non-significant χ^2 value of 0.3 (1 df). Thus our hypothesis must be rejected, and we conclude that re-entry behaviour is independent of the time of the incident.

TABLE 95. Extent of Smoke Spread by re-entry behaviour

Return into the building	Extent of Smoke Spread					Total
	Little or none	Confined to room of origin	Confined to floor of origin	Spread to floor above	Even more extensive	
Not return	34 (5.1) (42.5)	159 (23.9) (53.4)	203 (30.5) (53.1)	175 (26.3) (61.2)	94 (14.1) (66.2)	665 (56.0)
Return	46 (8.8) (57.5)	139 (26.6) (46.6)	179 (34.2) (46.9)	111 (21.2) (38.8)	48 (9.2) (33.8)	523 (44.0)
Total	80 (6.7)	298 (25.1)	382 (32.2)	286 (24.1)	142 (12.0)	1188 (100.0)

TABLE 96. Smoke Density by re-entry behaviour

Return into the building	Smoke Density scale-values							Total
	1	2	3	4	5	6	7	
Not return	94 (14.1) (43.9)	75 (11.3) (49.0)	156 (23.5) (59.8)	134 (20.2) (60.4)	121 (18.2) (63.0)	50 (7.5) (57.5)	35 (5.3) (59.3)	665 (56.0)
Return	120 (22.9) (56.1)	78 (14.9) (51.0)	105 (20.1) (40.2)	88 (16.8) (39.6)	71 (13.6) (37.0)	37 (7.1) (42.5)	24 (4.6) (40.7)	523 (44.0)
Total	214 (18.0)	153 (12.9)	261 (22.0)	222 (18.7)	192 (16.2)	87 (7.3)	59 (5.0)	1188 (100.0)

TABLE 97. Time of the incident by re-entry behaviour

Return into the building	Time of incident		Total
	Day	Night	
Not return	512 (77.0) (55.5)	153 (23.0) (57.5)	665 (56.0)
Return	410 (78.4) (44.5)	113 (21.6) (42.5)	523 (44.0)
Total	922 (77.6)	266 (22.4)	1188 (100.0)

12.4 EFFECT OF FIRE VARIABLES ON MOVEMENT THROUGH SMOKE

It is rather difficult to construct a priori hypothesis concerning movement through smoke, without the knowledge of what motivates people to undertake this action. It is possible that in many incidents, any movement during the course of the fire will entail movement through smoke. Alternatively, there is a body of anecdotal evidence which suggests that people are in fact very reluctant to move into smoke. We will explore the effects of the Fire variables on the occurrence of this action in the same order as in preceding analyses.

12.4.1 EFFECT OF LEVEL OF FIRE SEVERITY INDEX ON MOVEMENT THROUGH SMOKE

The cross-tabulation of whether or not an individual moved through smoke against the level of FSI is shown in Table 98 overleaf. It will be noted that although there is considerable variation in the percentage of people moving through smoke at different levels of FSI, there does not appear to be a consistent trend ($\chi^2 = 16.7$ (4 df), significant beyond the 0.01 level).

12.4.2 EFFECT OF USE OR NON-USE OF JETS ON MOVEMENT THROUGH SMOKE

The cross-tabulation of whether or not an individual moved through smoke against whether Jets were used is shown in Table 99 (p.241). It appears that a rather smaller percentage of people move through smoke in incidents in which Jets are used; however testing on the frequencies in Table 99 yields a χ^2 value of 4.3 (1 df), which fails to reach our pre-set 1% rejection level and is thus non-significant. We therefore conclude that movement through smoke is independent of the time of the incident.

TABLE 98. Level of FSI by movement through smoke

Move through smoke	FSI level					Total
	Very Low	Low	Medium	High	Very High	
Not move	129 (16.8) (44.3)	270 (35.1) (40.8)	155 (20.2) (34.6)	127 (16.5) (48.5)	88 (11.4) (36.5)	769 (40.4)
Move	162 (14.3) (55.7)	391 (34.5) (59.2)	293 (25.8) (65.4)	135 (11.9) (51.5)	153 (13.5) (63.5)	1134 (59.6)
Total	291 (15.3)	661 (34.7)	448 (23.5)	262 (13.8)	241 (12.7)	1903 (100.0)

TABLE 99. Use of Jets by movement through smoke

Move through smoke	Use of Jets		Total
	Not used	Used	
Not move	477 (62.0) (38.7)	292 (38.0) (43.6)	769 (40.4)
Move	756 (66.7) (61.3)	378 (33.3) (56.4)	1134 (59.6)
Total	1233 (64.8)	670 (35.2)	1903 (100.0)

12.4.3 EFFECT OF EXTENT OF SMOKE SPREAD ON MOVEMENT THROUGH SMOKE

The cross-tabulation of whether an individual moved through smoke against the extent of Smoke Spread is shown in Table 100 overleaf. It can be seen from this table that there is a steady increase in the percentage of people moving through smoke up to our highest category, at which point there is a decline in the percentage. This association is confirmed by the χ^2 value of 26.9 (4 df), which is significant beyond the 0.001 level.

12.4.4 EFFECT OF SMOKE DENSITY ON MOVEMENT THROUGH SMOKE

The cross-tabulation of whether or not an individual moved through smoke against the density of the smoke is shown in Table 101 overleaf. Again we have considerable variation in percentages moving through smoke at different values of Smoke Density, although there is no consistent trend. The anomalous percentages appear to occur at the extremes of Smoke Density, since there is otherwise a consistent decrease in movement through smoke between scale-values 2 and 6. The frequencies in this table yield a χ^2 value of 30.3 (6 df), which is significant beyond the 0.001 level. It is interesting that, if we analyse this χ^2 value, we find that for the highest level of Smoke Density (i.e. scale-value 7), the observed and expected frequencies are very similar, whereas the observed frequency of people moving through smoke in scale-value 1 is considerably less than the expected frequency. (There are of course other differences between observed and expected frequencies in the table.) It would seem therefore that there is a tendency for increased Smoke Density to be associated with decreased likelihood of movement through smoke, although the relationship is imperfect.

TABLE 100. Extent of Smoke Spread by movement through smoke

Move through smoke	Extent of Smoke Spread					Total
	Little or none	Confined to room of origin	Confined to floor of origin	Spread to floor above	Even more extensive	
Not move	75 (9.8) (54.4)	275 (35.8) (45.2)	214 (27.8) (37.6)	143 (18.6) (33.9)	62 (8.1) (37.3)	769 (40.4)
Move	63 (5.6) (45.6)	333 (29.4) (54.8)	355 (31.3) (62.4)	279 (24.6) (66.1)	104 (9.2) (62.7)	1134 (59.6)
Total	138 (7.3)	608 (31.9)	569 (29.9)	422 (22.2)	166 (8.7)	1903 (100.0)

TABLE 101. Smoke Density by movement through smoke

Move through smoke	Smoke Density scale-values							Total
	1	2	3	4	5	6	7	
Not move	224 (29.1) (46.4)	92 (12.0) (31.6)	133 (17.3) (33.6)	133 (17.3) (41.4)	109 (14.2) (45.4)	51 (6.6) (49.5)	27 (3.5) (39.1)	769 (40.4)
Move	259 (22.8) (53.6)	199 (17.5) (68.4)	263 (23.2) (66.4)	188 (16.6) (58.6)	131 (11.6) (54.6)	52 (4.6) (50.5)	42 (3.7) (60.9)	1134 (59.6)
Total	483 (25.4)	291 (15.3)	396 (20.8)	321 (16.9)	240 (12.6)	103 (5.4)	69 (3.6)	1903 (100.0)

12.4.5 EFFECT OF TIME OF THE INCIDENT ON MOVEMENT THROUGH SMOKE

The cross-tabulation of the time of the incident against whether or not an individual moved through smoke is shown in Table 102 below.

TABLE 102. Time of the incident by movement through smoke

Move through smoke	Time of incident		Total
	Day	Night	
Not move	650 (84.5) (42.4)	119 (15.5) (31.6)	769 (40.4)
Move	876 (77.2) (57.4)	258 (22.8) (68.4)	1134 (59.6)
Total	1526 (80.2)	377 (19.8)	1903 (100.0)

Inspection of Table 102 shows that, surprisingly, a greater percentage of people move through smoke in night-time incidents. This relationship is statistically significant ($\chi^2 = 15.2$ (1 df), significant beyond 0.001). Thus, people are more likely to move through smoke in night-time incidents.

12.5 DISCUSSION

The evidence presented in Chapter 12 indicates that, like the Building and Personal variables considered in the immediately preceding chapters, the nature of the fire incident itself, as characterised in the Fire variables, can have an important influence upon behaviour. We have, however, seen that several of these effects act in directions which we would not have predicted. In discussing the interaction of these variables, it is convenient to consider them under specific headings.

12.5.1 PATTERNS OF BEHAVIOUR

Four of the measures used in this chapter relate to the severity of the fire, and it is encouraging that there are many similarities in the way in which these variables affect patterns of behaviour. A continuing theme is the very predictable finding that evacuating oneself, either as a single course of behaviour, or as part of a behaviour pattern, tends to increase markedly in frequency as the fire becomes more severe. Much more surprising is the relationship between contacting the Fire Brigade and Fire Severity, for we find that in each case this behaviour pattern is considerably more common in Low severity fires than High severity ones, the reverse of what we might have expected. Fire-fighting also tends to predominate in Low rather than High severity fires, which suggests that many individuals perceive fairly accurately those fires which they are capable of tackling unaided. It is interesting that attempts to minimise the risk, such as shutting doors and switching-off gas or electricity supplies, are additionally more frequent in Low severity incidents, since these actions might be classed as "negative fire-fighting". Behaviour patterns which incorporate minimising the risk more often appear to contain other "responsible" actions, such as contacting the Fire Brigade, evacuating others or alerting others, and less often to contain such actions as evacuating oneself and fire-fighting.

If we hypothesise that High severity fires are associated with high levels of threat to the individual then it would seem reasonable that night-time incidents, which must also be more threatening, would exhibit similar behaviour patterns, a hypothesis which is in this case supported to some extent. Certainly contacting the Fire Brigade is less frequent at night, whilst alerting others is more frequent, as it also is in High FSI value fires. We are, however, constrained from drawing firm conclusions about this due to the fact that less than 20% of the incidents occurred at night.

12.5.2 EVACUATION BEHAVIOUR

In looking at whether or not people left the building at all during the course of the incident, we cannot fail to be impressed by the uniform way in which the variables act. Each of our Fire Severity measures acts to increase the likelihood of individuals leaving, as does the absence of daylight. These findings are of course based upon the responses of the 2193 interviewees. As we also have data on evacuation from the Fire Brigade personnel present at the incident, it is possible to analyse this in terms of the proportion of people who left the building at each of the 952 incidents. In four of the five cases this additional data tends to support the primary analysis, the one variable for which this does not happen being the time of the incident. This suggests that in night-time incidents there may have been a bias towards interviewing those who left the building rather than those who did not. Other than this contradictory finding, it would seem clear that increases in Fire Severity are very directly related to increased likelihood of people leaving the building.

12.5.3 RE-ENTRY BEHAVIOUR

We would naturally predict that as Fire Severity increased, so the proportion of people who returned into the building would decrease. In fact this inverse relationship is demonstrated for three of our Fire Severity measures but not the fourth, the use of Jets. It would seem from this that re-entry behaviour may be determined more by smoke characteristics than other aspects of the fire.

Rather surprisingly we find that re-entry behaviour is independent of the time of the incident, since we would have expected fewer people to return into the building during night-time incidents, although it is likely that under these circumstances many people would re-enter to obtain warm clothing, etc.

12.5.4 MOVEMENT THROUGH SMOKE

The effect of the Fire variables on movement through smoke is less straightforward than their influence upon evacuation or re-entry behaviour. An obvious hypothesis is that people will be less inclined to move through smoke as the severity of the fire increases. This simple relationship is, however, not demonstrated. Our overall measure of Fire Severity, the FSI level, is associated with movement through smoke in the sense that there is an overall significant χ^2 value, although there is no consistent trend, whilst the use or non-use of Jets has no effect. Increased Smoke Spread appears to have the effect of increasing the proportion of people moving through smoke which is not unreasonable; however we also find that the absence of daylight has this effect, an association which is resistent to explanation.

Only in the case of Smoke Density does the association appear intuitively reasonable, with a decreasing percentage of individuals moving through smoke as its density increases. The variable, Smoke Density, is, of course, based upon a Fire Brigade estimate, and it is interesting to compare this with the estimates made by the interviewees of how far they could see when they moved through the smoke. Using Spearman's rank correlation coefficient we obtain a value of 0.61 (significant beyond the 0.001 level), indicating a close relationship. Examination of the data suggests that the interviewees' estimates achieve their highest values at a point somewhat below the top of the Fire Brigade scale. Specifically, we find that estimates of "zero" visibility made by the occupant often correspond with scale-values of 4 or 5 on the 7-point Fire Brigade scale. A further aspect of smoke visibility estimates is the relationship between them and the distances which individuals will move through smoke. In this case the Spearman correlation coefficient for "distance see/distance move" is a rather lower value of 0.43 (significant beyond the 0.001 level). We may again examine the data for the source of inconsistency and we find, for example, that half the people who moved 10 yards through smoke stated they could only see 4 yards in front of them, implying that at least in some conditions, people are prepared to move further through smoke than their range of visibility.

CHAPTER 13

FACTORIAL ANALYSIS OF SELECTED STUDY VARIABLES

13.0 FACTORIAL ANALYSIS OF SELECTED STUDY VARIABLES

In the preceding seven chapters we have examined the relationship between pairs of variables by means of significance testing. There is little doubt that for this purpose, the χ^2 test is the most appropriate statistical tool. There remains, however, the problem of investigating firstly the strength of any associations which have been demonstrated, and secondly the existence of interactions between the variables. These two aspects will be examined within this chapter.

The statistical technique utilised, weighted factorial logistic analysis, is briefly described in Section 5.6.2. As was discussed therein, this method of analysis is most commonly applied to dichotomous variables, and it is therefore only appropriate in the present case for selected variables.

13.1 VARIABLES ANALYSED

Twelve variables were considered suitable for analysis. These comprised 5 Personal variables, 3 Fire variables, 1 Building variable and 3 Behavioural variables. The selection of the variables was based upon two considerations. The major factor was of course whether the variable was dichotomous, or could be recategorised as such in a reasonable way. The other factor considered was the findings from the earlier analyses, obviously those variables which had been shown to be involved in several associations, or which were of particular interest, being given preference over those which were not.

The variables selected for analysis were as follows:

Personal variables

1. Sex of the person involved
2. Training of the person involved
3. Familiarity of the person with the building
4. Previous involvement of the person in a fire incident
5. Age of the person involved

Fire variables

6. Presence of smoke in the incident
7. Extent of Smoke Spread in the incident
8. Time of day of the incident

Building variable

9. Category of building in which the incident occurred

Behavioural variables

10. Whether the person left the building during the course of the incident
11. Whether the person returned into the building during the course of the incident
12. Whether the person moved through smoke during the course of the incident.

The variables numbered 1, 4, 6, 10, 11 and 13 are dichotomous by nature, the two levels for each being

1. Male ... Female
4. Previously involved ... Not previously involved
6. Smoke present ... Smoke absent
10. Leave the building ... Not leave the building
11. Return into the building ... Not return into the building
12. Move through smoke ... Not move through smoke.

In addition to the above, variables numbered 2, 3, 7 and 8 have already been used in dichotomous form in earlier analyses, and we will utilise the same reclassifications here. The two levels of these are

2. Some training ... No training
3. Completely familiar ... Less than completely familiar
7. Smoke Spread confined to the floor of origin ... Smoke Spread beyond the floor of origin
8. Daytime (0600 to 2159) ... Night-time (2200 to 0559).

This leaves us with two variables, Age and Building category, to consider. Reference to Figure 4 (p.52) shows that the age of those interviewed is approximately normally distributed and we may therefore divide it at the mode. The two levels are therefore

5. Young (under 40 years) ... Old (40 years or over)

With regard to category of building, reference to earlier analyses suggests that incidents which occur in Dwellings may be substantially different, both in nature and in manifest behaviour. Since they also represent the "home" environment, whereas all the other categories are to some degree "working" environments, we have chosen to recategorise our building types into "Dwelling" and "Non-Dwelling". The two levels are therefore

9. Home ... Work

Having defined our selected variables in binary form they were then subjected to factorial analysis. The largest number of combinations of variables which could be analysed simultaneously was found to be 5. Larger numbers than this produced zero values in some cells. Note that combinations which included both "Presence of smoke" and "Smoke Spread" variables, and also those including "Presence of smoke" and "Whether moved through smoke" were obviously not considered. In total, 121 analyses of Personal/Fire/Building variables against a Behavioural variable were examined. In each case estimates of main effects, first, second and third order interactions, were produced. As in earlier analyses, only those which attained the 0.01 level of probability were considered significant.

13.2 MAIN EFFECTS

We would expect the main effects to offer confirmation of our earlier significance testing and to indicate the strength of any associations.

13.2.1 EVACUATION BEHAVIOUR

The results of the analysis in terms of the main effects of the variables upon whether or not an individual left the building are summarised in Table 103 overleaf. The value of the Z-score indicates the strength of the relationship, and it will be noted from this table that the first four variables have an extremely powerful effect on increasing evacuation. It is of interest that the two most powerful variables are not related to differences between people, but to differences in the nature of the fire and the building in which it occurs.

TABLE 103. Main effects of variables on evacuation behaviour

Variable	Level	Z-score	Significance level
Smoke Spread	Extensive	11.85	0.00001
Building category	Home	10.42	0.00001
Previous involvement	Not	7.89	0.00001
Sex	Women	5.83	0.00001
Age	Young	4.27	0.001
Training	No	3.77	0.01
Familiarity	-	2.38	n.s.
Presence of smoke	-	2.26	n.s.
Time	-	0.89	n.s.

13.2.2 RE-ENTRY BEHAVIOUR

The results of the analysis in terms of the main effects of the variables upon whether or not an individual returned into the building are summarised in Table 104 below.

TABLE 104. Main effects of variables on re-entry behaviour

Variable	Level	Z-score	Significance level
Sex	Men	6.22	0.00001
Smoke Spread	Less extensive	4.55	0.0001
Presence of smoke	Present	2.71	0.01
Previous involvement	-	1.97	n.s.
Familiarity	-	1.92	n.s.
Time	-	1.92	n.s.
Building category	-	1.80	n.s.
Age	-	0.71	n.s.
Training	-	0.31	n.s.

It will be noted that the values of the Z-scores for re-entry behaviour do not reach such extreme levels as for evacuation, nor do so many of the variables have a significant effect.

13.2.3 MOVEMENT THROUGH SMOKE

The results of the analysis in terms of the main effects of the variables upon whether or not an individual moved through smoke are summarised in Table 105 overleaf.

TABLE 105. Main effects of variables on movement through smoke

Variable	Level	Z-score	Significance level
Sex	Men	4.67	0.0001
Smoke Spread	Extensive	4.56	0.0001
Building category	Home	4.37	0.0001
Time	-	4.37	0.0001
Familiarity	Completely	3.05	0.01
Previous involvement	-	0.96	n.s.
Age	-	0.66	n.s.
Training	-	0.37	n.s.

In the case of movement through smoke, we appear to have a number of variables which act with similar strength. Again it is of interest that the Non-Personal variables generally seem to be of either equal or greater importance than many Personal variables, in determining this type of behaviour.

We will now turn our attention to considering the significant interactions between the variables.

13.3 INTERACTIONS INVOLVING EVACUATION BEHAVIOUR

Three first order interactions were significant, no lower order interactions attaining the 0.01 level of probability. The significant interactions will be discussed in descending order of Z-score value.

(i) Training and Smoke Spread (Z-score = 3.06, significance level 0.01)

The findings for this analysis were as follows:

(a) Differences in training only affect evacuation behaviour under conditions of less extensive Smoke Spread. Under these conditions, people who have received training tend to leave less frequently than those who have not.

(b) The proportion of people leaving the building is much greater when the smoke spreads extensively than when it does not.

(ii) Building category and Familiarity (Z-score = 2.83, signif level 0.01)

The findings for this analysis were as follows:

(a) Differences in familiarity only affect evacuation behaviour in the home environment, increasing familiarity tending to increase the proportion of people leaving.

(b) The proportion of people leaving the home environment is greater than in the work environment, irrespective of familiarity.

(iii) Building category and Presence of Smoke (Z-score = 2.74, signif level 0.01)

The findings for this analysis were as follows:

(a) The presence or absence of smoke only affects evacuation behaviour in the work environment. In these category buildings, the presence of smoke acts to increase the proportion of people leaving.

(b) The proportion of people leaving the home environment is greater than in the work environment, irrespective of whether smoke is present or absent.

13.4 INTERACTIONS INVOLVING RE-ENTRY BEHAVIOUR

Only one first order interaction was significant, no lower order interactions attaining the 0.01 level of probability.

(i) Age and Presence of smoke (Z-score = 2.59, signif level 0.01)

The findings for this analysis were as follows:

(a) The presence or absence of smoke only affects the re-entry behaviour of young people. For these people, the presence of smoke acts to increase the proportion who return into the building.

(b) When smoke is present, the proportion of people who return into the building is independent of age.

13.5 INTERACTIONS INVOLVING MOVEMENT THROUGH SMOKE

Again, only one first order interaction was significant, no lower order interactions attaining the 0.01 level of probability.

(i) Time and Smoke Spread (Z-score = 2.62, signif level 0.01)

The findings for this analysis were as follows:

(a) The extent of Smoke Spread only affects whether or not individuals move through smoke in night-time incidents. Under these conditions, the proportion of people who move through smoke increases as the smoke spreads more extensively.

(b) Under conditions of extensive Smoke Spread, the proportion of people who move through smoke is independent of whether it is night-time or daytime.

13.6 DISCUSSION

The major point concerning the factorial analysis is that in most cases the main effects are clearly much more important than the interactions. This is particularly true in the case of evacuation behaviour, where the action of increased Smoke Spread, home environment, non-previous involvement, women rather than men, and young rather than old, are up to four times more powerful than the interaction effects. Thus whilst the interactions are of interest, we should not lose sight of their relative position.

Examining all the significant main effects which act to increase evacuation behaviour, it would appear that three factors may be operating. Firstly there is a component associated with increased threat level, secondly one associated with increased susceptibility to be threatened, and thirdly an element concerned with the practical, ease-of-ability in leaving. The first of these is illustrated by the presence of smoke and extensive Smoke Spread, the second by lack of training or previous experience of fire and "femaleness", and the third by home environment, youth and complete familiarity with the building.

Of the significant main effects which act to increase re-entry behaviour, we might well have predicted that less extensive Smoke Spread would act in this way, and perhaps also that men would be more likely to undertake this behaviour; however the fact that it is more common in incidents where smoke is present than where it is absent is resistent to reasonable explanation.

A similar predicament arises when considering the main effects which act to increase the proportion of people moving through smoke. Four of the five significant main effects act in a predictable direction, a greater proportion of men, in the home who are completely familiar with the building, during daylight attempting this behaviour. However the association of high levels of Smoke Spread with more frequent movement through smoke seem less reasonable. Extensive Smoke Spread has been characterised earlier as a potent threat cue, and yet it does not appear to act in this way in discouraging movement through smoke. The simple explanation may be that in incidents where smoke spreads extensively, any movement in the building will involve movement through smoke.

With regard to the interactions which increase evacuation, it is instructive that two of these show strongly the main effect of the home environment. Individuals appear to leave the home environment much more frequently, despite changes in other variables. These differences between the working environment and home environment may reflect the fact that at work individuals may be "evacuated", that is, ordered to leave the building. Obviously the presence of smoke is likely to make such an instructed evacuation more likely, and also accounts for the fact that evacuation at work is independent of familiarity. If we consider why familiarity with the building should only act on people in the home, we should first give thought to with which category of "home" building people are less than completely familiar. The answer in the present case is high-rise flats. We are therefore seeing an interaction which reflects one category of dwellings only. The third interaction relating to evacuation, that between Smoke Spread and training, is of some interest. It would seem from this interaction that the increased threat of extensive Smoke Spread largely obscures any differences in training. We might suggest that extensive Smoke Spread is a much more powerful agent for increasing threat than training is for reducing it.

The interaction of the presence of smoke and age in relation to re-entry behaviour is again difficult to interpret. It would certainly seem that young people perceive much less threat in the presence of smoke than do older people, although whether this reflects over-confidence on the part of the young or superior knowledge on the part of the old, we can only conjecture.

The variables which act differentially on movement through smoke are also probably not explicable in terms of threat level. In this case, night-time and extensive Smoke Spread both serve to increase the proportion of people who move through smoke. It is likely that the previously-offered explanation that, under such conditions, any movement whatsoever is likely to be through smoke, applies.

This chapter concludes the quantitative examination of data. In the following three chapters we will example a sub-sample of incidents, those including rescues, injuries and fatalities, in a qualitative manner.

CHAPTER 14

QUALITATIVE EXAMINATION OF INCIDENTS INVOLVING NON-FATAL INJURIES

14.0 A QUALITATIVE EXAMINATION OF INCIDENTS INVOLVING NON-FATAL INJURIES

Of the 952 fire incidents covered in the Full-Scale Study, 52 (55%) involved non-fatal injuries to one or more people. In this section we will examine a selection of these particular incidents in some detail.

Of the 52 incidents involving non-fatal injuries, 44 were Dwelling fires, 2 were in Garages and 1 each in a Hotel, Warehouse, Factory and Shop*.

14.1 NON-DWELLING INCIDENTS INVOLVING INJURIES

(i) Incident 66 - Hotel

This fire, which was perhaps among the potentially most serious of the sample, occurred at 2136 in an eight-storey hotel in Central London. (It has the distinction of being the fire with the largest number of people interviewed at a single incident in the Present Study, 12.) It was a 3 Jet fire with a calculated Fire Severity Index of 25. All 300 occupants of the building were evacuated, 2 received non-fatal injuries and 12 were rescued by Fire Brigade personnel (one of whom was interviewed).

This is clearly one of a relatively small percentage of incidents where the occupants were either completely unfamiliar with the building or only slightly familiar with it, and it is interesting to observe that the 12 people interviewed either immediately left the building, or began some preparations to do so. This applied not only to those on the same floor as the fire (the sixth), but also those on floors below it.

The person who was rescued by turntable ladder, a woman aged 23, was on the sixth floor. She smelt smoke and thought the fire was "extremely serious". She actually tried to leave the building by going down the

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* Of the total 52 fires which included non-fatal injuries, 1 Factory fire and 1 Dwelling fire also involved fatalities. Similarly, of the 13 incidents involving rescues, 1 Factory and 1 Dwelling fire also involved fatalities. These incidents have been excluded from the analyses in this section. The total number of incidents which involved injury but <u>not</u> a fatality is thus 50. The total number of incidents which involved rescue but not a fatality is 11. Discussion of incidents which involve fatalities will be deferred until Chapter 15.

corridor, but the smoke became too thick and she had to turn back to her room. She then went to the bathroom to get a wet flannel for her face, climbed onto a ledge outside the building and waited to be rescued. It is interesting that another occupant on the sixth floor in trying to leave was also turned back by the thickness of the smoke. She also returned to her room, and put a wet towel over her face. She was then able to leave by using an emergency exit.

A further interesting point from that fire is that all of the 12 people interviewed spontaneously mentioned saving some personal effects, not an action which is common in other types of incident.

The two individuals who were injured were attempting to leave the building at the time, and collapsed in the dense smoke. They were rescued by Fire Brigade personnel wearing breathing apparatus. Their injuries amounted to no more than the effects of smoke inhalation.

One thing is clear from this incident, that the first reaction of individuals in an unfamiliar building is to attempt to leave immediately, and they will pursue this course of action even in the face of quite dense smoke. In this case the people injured received their injuries whilst actually trying to do this, and in some ways were fortunate to be alive. The 23 year old woman interviewee who was rescued may be considered to have behaved more sensibly.

(ii) Incident 60 - Factory

This fire occurred at 0918 in a single-storey engineering factory in Glasgow. Thirty of the forty people in the building were evacuated, one of whom received injuries in trying to escape. It was a single Jet fire with a calculated Fire Severity Index of 12.

Of the 6 people interviewed, 5 were very close to the fire, and their first awareness of it was seeing the flames. Not a single one of the interviewees mentions warning other people, (or indeed fighting the fire). All seemed concerned only with getting themselves out of the building, for example, the First Actions of four of them (all men) were ... "Hurried to Fire Exit" ... and ... "Ran away from it" ... and ... "Ran for Exit" ... and "Grabbed jacket and ran for an Exit door". This is really quite unusual, in that if six people were interviewed, at least one would usually have been concerned with warning other people, raising a general alarm, or perhaps contacting the Fire Brigade. In this case we do not know how the injured person received his injuries, nor their extent. None of those interviewed had to move through smoke and it is likely that the injuries were received in an over-hasty attempt at evacuation, rather than as a direct result of the fire.

In view of the fact that this was a single-storey building, and that therefore no-one could possibly be trapped above the fire, ... that there was a fire alarm in the building, but it was not used, ... that there was fire-fighting equipment in the building, but this also was not used, ... that five of the six interviewees had received some training, but all left the building immediately, this seems a most untypical factory fire.

(iii) Incident 531 - Garage

This fire started when a 40 year old mechanic was welding a car.. The car caught fire, as did the man's clothing. His actions make interesting, and rather horrifying reading. He said that he

> "Ran from the garage and beat out the burning clothing on his person"
>
> "Attempted to get the car out of the garage, but the heat and flames developed too rapidly"
>
> "Ran out of the garage and asked someone to call the Fire Brigade".

Astoundingly he then returned in and tried to move the car out of the garage again. He was obviously concerned about the quantities of oil, petrol, etc, which were present. However, his actions seem either foolhardy or brave for someone who was subsequently treated for burns, albeit minor ones. The fire was eventually extinguished by the Fire Brigade using 2 hose-reels, and the Fire Severity Index was calculated to be 14.

The reason for the injury in this case is simple, the man was welding without taking proper precautions. He also compounded this by not having an extinguisher close to hand whilst welding, and the combination of these errors together with his rather ill-considered actions could have resulted in his injuries being much more serious.

(iv) Incident 886 - Warehouse

This fire occurred at 2213 in a large single-storey warehouse adjacent to a textiles factory. Two people were injured by inhaling smoke whilst fighting the fire. It was a most severe fire, requiring 8 Jets, and the Fire Severity Index was calculated to be 36. The actions of the six interviewees make an interesting contrast with those in the earlier-discussed factory incident (number 60). A sample of their stated actions is given below.

> "Dialled emergency code for factory and informed security of the fire"
>
> "Helped to evacuate other Departments"
>
> "Operated internal fire alarm"
>
> "Closed fire door to other Department"
>
> "Tried to help as best I could".

All the comments were of this nature, and ranged through fighting or containing the fire to warning others or helping evacuation. All of those interviewed moved through smoke at some stage of the incident.

As will be realised, the general level of cooperation, concern with containing the fire and for the safety of others is completely different from the behaviour manifested in Incident 60.

Perhaps the explanation lies in the level of training of the two groups. In Incident 60, 4 of those involved had received training "at least once per year", whereas in Incident 886, only 1 of those interviewed received training as infrequently as this, the others having received training either at least every six months (2) or at least every month (3). It would seem therefore that this difference in frequency, and perhaps quality of training, makes an enormous difference to the behaviour which occurs when there is a fire.

One other difference between the incidents, which may be completely irrelevant, is that Incident 886 occurred in Liverpool while Incident 60 occurred in Glasgow. At the anecdotal level, Liverpudlians are said to be particularly close-knit as a group. However this is merely a speculative thought.

14.2 DWELLING INCIDENTS INVOLVING INJURIES

With the greater number of fires in this group, it is feasible to inspect the incidents for both commonality of cause and ways in which injuries occur. It is not possible to identify the cause of fire in every case, but the 24 identifiable cases are shown in Table 106 below.

TABLE 106. Causes of Dwelling fires involving Injuries

Cause of fire	Frequency
Chip pan catching fire	15
Smoking in bed	5
TV fire	2
Gas oven,,explosion	2
Paraffin heater fire	2
Cause unknown	18
Total	26

It can be seen that chip pan fires far outnumber any other single cause of fire involving injury.

If instead of looking at the cause of fire we examine how the injury was caused, we can see again that one particular category stands out and this is illustrated in Table 107 below.

TABLE 107. Cause of Injury in Dwelling fires

Cause of fire	Frequency
Attempt to move burning object	17
Blast from explosion	2
Smoke inhalation whilst trying to rescue pets	4
Children being dropped from window	1
In attempting to rescue a child	1
Cause unknown	19
Total	44

The simple breakdowns shown in Tables 106 and 107 give us some framework for qualitatively examining injury-producing dwelling fires.

14.2.1 CHIP PAN FIRES

With 15 identified cases, this group is the largest of those where we know the cause of fire. Not only does it figure large in causes of fire, but 13 of the 17 cases where injury was caused by attempting to move the burning object are attributable to chip pan fires. Since they are clearly such a common type of fire we will consider them in a more general way in Section 14.3. Meanwhile, we will examine some examples of incidents which occurred in the Present Study.

(i) Incident 227

This fire started at lunchtime, the 25 year old wife discovered the fire, and attempted to remove the chip pan from the cooker. In doing this she fell with the burning pan, which she then abandoned and dragged her young child from the kitchen. She was burned in dropping the pan. Her 29 year old husband heard shouts from his wife and arrived at the kitchen in time to see his wife drop the pan. He helped her out, went to the living room and removed the other child. He then re-entered the kitchen, switched-off the cooker and left the house to dial 999.

(ii) Incident 442

This fire occurred in the mid-afternoon. A 32 year old woman was alone in the house when she smelt smoke. On discovering the chip pan was on fire she removed the hot pan from the cooker, burning herself in the process, and threw it out of the door. She then dialled 999 and fainted.

(iii) Incident 516

This fire occurred on the first floor of a three-storey block of flats at 1730. The 60 year old wife discovered the chip pan ablaze on entering the kitchen. She went back to the living room and told her husband. He directed her to switch-off the electricity supply at the mains which she did. Meanwhile he went into the kitchen, picked up the chip pan and carried it through the living room onto the verandah of the flat; while doing this he received burns. He then threw the pan onto the ground.

(iv) Incident 642

This fire also occurred in a first floor maisonette of a three-storey block of flats. The 30 year old wife saw the smoke from the burning chip pan and shouted to her husband. He entered the kitchen, picked up the pan and carried it to the outside door, which he told his wife to open for him. As she did this, the fire flared-up with the draught from the open door, and flames and burning fat went over the wife. The husband threw the pan outside.

(v) Incident 838

This fire occurred at 1818 in a dwelling. The 72 year old woman, who lived alone, first discovered the fire by seeing smoke. She went into the kitchen and discovered the burning chip pan. She turned the gas off at the cooker, opened the back door, removed the pan from the cooker and took it outside, receiving burns as she did so. She finally threw a pan of water over the still-burning pan.

(vi) Incident 478

This fire occurred at midday in the ground floor flat of a three-storey block of flats. The 89 year old wife discovered the fire and told her 92 year old husband. He went into the kitchen, removed the chip pan from the cooker and threw it outside onto the steps, receiving burns as he did so. His wife meanwhile removed the rug from the kitchen floor lest burning fat should drop on it.

These six incidents clearly illustrate the course of events in many chip pan fires. The circumstances and behaviour of those involved is amazingly similar. They are examples of the main way in which injuries occur in these incidents. A slight variation on this theme is provided by the further examples given below.

(vii) Incident 457

This fire occurred in a dwelling at lunchtime. The two male occupants became aware of the fire roughly at the same time. One dashed into the kitchen and covered the burning pan with a towel, and then went and switched-off the electricity at the mains. Meanwhile his companion ran up to the bathroom to fetch more towels, which the first man put over the pan. Unfortunately the towels failed to extinguish the fire, so the man picked up the pan and threw it out, being burned as he did so. The other man then rang for the Fire Brigade.

(viii) Incident 509

This fire also occurred in a dwelling at lunchtime. The 57 year old wife discovered the fire and shouted to her 58 year old husband that the chip pan was on fire. He ran into the kitchen and put a wet cloth over the chip pan. He then attempted to take the chip pan outside, whereupon burning fat splashed onto him.

(ix) Incident 779

This fire occurred in a dwelling occupied by a 23 year old man, his wife and young child, at lunchtime. The man first became of the fire by seeing smoke and he went to investigate the cause. When he saw the chip pan was on fire he looked for an old coat which he threw over it. He then attempted to move the pan out of the building, and received burns to his arms.

(x) Incident 346

This fire occurred in the evening on the second floor of a three-storey block of flats. The 37 year old wife discovered the fire and shouted to her 50 year old husband. He grabbed an extinguisher and tried to put the fire out. He was unsuccessful in quenching the fire so he tried to carry the pan outside. He was burned whilst attempting to do this.

We can see in these four examples that although the final outcome is the same as in the previous six fires, the events which led up to the injury are slightly different. In these cases an attempt was made to extinguish the chip pan fire in the approved manner (except for Incident 346), and only when the approved fire-fighting technique appeared to fail, did someone try to move the pan and thus receive injuries. In the case of Incident 346, this would seem to illustrate the ineffectiveness of many small fire extinguishers sold for household use. The Fire Services do not generally approve of them, suggesting that they may impart a false sense of security, whilst at the same time not having the capacity to deal with something like a chip pan fire, as was the case in this incident.

Before moving on to discuss other types of injury-producing dwelling fires, we should note that one particular chip pan fire contained the ingredients for a horrifying multiple-fatality incident. It is described below.

(xi) Incident 413

This fire occurred at 2245 in a first floor flat over a ground floor shop. Two young girls, aged 10 and 13 years, had been left in the house to look after a young baby whilst their parents were out. When the 13 year old girl smelt smoke she went to investigate. On discovering the chip pan (which had been left on the cooker over a low light) ablaze, she telephoned an aunt. She then took the pan from the cooker and put it in the sink, receiving burns to her arms whilst doing this. She then left the building. Her 10 year old sister had meanwhile picked up the baby, come downstairs and gone outside.

It is clear that had the fire been allowed to develop for only a little longer, all three children might easily have perished.

14.2.2 ATTEMPTS TO MOVE THE BURNING OBJECT

We have seen that almost all the chip pan fires involved injuries received whilst carrying the burning chip pan. However this type of reaction is not confined to chip pan incidents alone. Two examples from other types of incident are given below.

(i) Incident 80

This fire occurred at 0936 in a dwelling. A 30 year old man, his 26 year old wife and young child were present in the building. The woman was smoking in bed, with her small son in a cot in the same second floor bedroom. She must have dozed-off to sleep because when she awoke she realised the bed was on fire. She called out to her husband and removed her small son from his cot. The husband ran upstairs to help her, and they then tried to push the burning bed through the bedroom window, breaking the glass in the process, while at the same time shouting to the neighbours to phone the Fire Brigade. When they realised the bed would not go through the window, they then tried to take the bed downstairs; however the still-burning bed became lodged halfway down, scorching the side of the stairs. At this stage the woman sustained burns to her leg and foot. The husband eventually pulled the bed clear and got it outside. He then returned into the building to remove clothes and other material which had set fire during the passage of the bed.

(ii) Incident 832

This fire occurred at 2215 on the second floor of a three-storey multi-occupancy dwelling. It developed into quite a severe fire, needing 2 hose-reels to extinguish it, and the Fire Severity Index was calculated at 18. Four people were rescued by Fire Brigade personnel and three sustained injuries. What appears to have happened is that a paraffin heater caught fire in the room of a 60 year old man. He then tried to remove the burning heater (to the bedroom); however he "accidentally dropped it downstairs" in transit. He thereupon shouted to the other occupants to get out and made his own exit through the bathroom window onto a roof, from whence he was subsequently rescued by the Fire Brigade.

It is clear from the evidence of Incidents 80 and 832 that the act of moving the burning object not only led to the person involved getting burned, but also endangered the lives of other occupants of the building, and probably substantially contributed to the eventual severity of the fire.

14.2.3 INJURIES SUSTAINED ON RETURNING INTO THE BUILDING

Although not as numerous as chip pan fires, with 5 cases this is the second largest group. Four of these are strikingly similar in that the individual returned into the building to attempt to rescue a pet. These four incidents are briefly discussed below.

(i) Incident 362

This fire occurred at 0039 on the ground floor of a two-storey dwelling house. The fire was very severe for a domestic one. It needed 2 Jets to extinguish it, the Fire Severity Index was calculated at 21, and was characterised by very dense smoke ("7" on the Fire Brigade scale). The sole occupant of the building, a man of aged 21, first became aware of the fire by smelling smoke. He then attempted to put the fire out, but when this was unsuccessful he ran into the hallway and dialled 999. He then decided to return into the building "... to rescue (the) bird and hamster in cages". In doing this he inhaled a lot of smoke and fumes, for which he had to be treated at hospital.

(ii) Incident 357

This fire started at 1220 on the first floor of a three-storey multi-occupancy building. It was a single Jet fire and the Fire Severity Index was calculated at 16. Two of the occupants remained in the building, however the third, a man aged 23 years who was on the ground floor, believing the fire to be "extremely serious", immediately made his exit via a ground floor window. On arriving outside he then re-entered the building in an attempt to rescue the dog, and this caused his injuries due to inhalation of smoke.

(iii) Incident 31

This fire occurred at 1931 on the ground floor of a two-storey dwelling. It was not a very severe fire, and the Fire Severity Index was calculated at 9; however there was extensive Smoke Spread throughout the building. The two occupants of the building were a man and his wife, both in their late forties. The wife smelt smoke, and she and her husband tried to smother the fire. They both left the building, the wife phoning the Fire Brigade. She then returned into the building to find the dog, and had to subsequently be treated for smoke inhalation.

(iv) Incident 547

This fire occurred at 0841 on the ground floor of a two-storey dwelling. One hose-reel was used in extinguishing it, the Fire Severity Index was calculated at 17 and there was fairly extensive spread of dense smoke. The sole occupant of the building, a man aged 40 years, first realised there was a fire by smelling smoke. He then investigated, dashed to the phone to ring the Fire Brigade, and then retreated out of the building. He subsequently returned into the building "... to rescue animals", and suffered injury due to inhalation of smoke.

The similarity of behaviour in these incidents is very clear. Whilst ownership of pets is obviously a common factor, this in itself is not unusual, some 28% of households in the UK own a dog (Joint National Committee on Pets in Society, 1975), and it is estimated that some 5 million households keep a caged bird (Secombs, 1978). What appear to be the critical factors are, a fire which is perceived as serious, leading to fairly immediate exit from the building, and the incident being one in which there is extensive spread of dense smoke. It is interesting that in two of the incidents the person was living alone, and one might intuitively expect the incidence of pet-ownership to be higher where people do live alone. Although in the cases considered the injury sustained may not have been serious, where there was only one person involved in the incident, and they return into a smoke-filled building, they are taking a very great risk, and the incident could easily lead to collapse whilst in the building and fatal inhalation of smoke and fumes.

The one other incident which involved injuries received on returning into the building is of a different type, and is briefly outlined below.

(v) Incident 753

This fire occurred at 1521 on the ground floor of a two-storey dwelling. Again this was a very severe fire for a dwelling, needing 2 Jets and having a calculated Fire Severity Index of 22. There were 5 occupants, a man and his wife, both aged 28, and their three young children. The adults both became aware of the fire by seeing flames and both thought it "extremely serious". The wife told the husband to get the small child who was in the bedroom on the first floor. She then ran out of the house. The husband lifted the two other children into the garden through a ground floor window, and then ran out of the back door, round to the front door, into the hall and up the stairs to rescue the small child from the bedroom. He then told his next door neighbour to ring for the Fire Brigade. He received his injuries in rescuing the small child.

14.3 DISCUSSION

Examination of the non-fatal injury incidents which occurred in the Present Study reveals that (a) the range of injury-types is very limited, and (b) the manner in which these injuries are sustained is also not subject to wide variation.

Basically, we can categorise our injury-incidents by combining injury-type/manner of occurrence in the following way:

(a) Burns, sustained by moving a burning object.

(b) Smoke-inhalation, sustained on returning into the building, in many cases to rescue a pet.

(c) Cuts, bruises and abrasions, sustained in leaving the building in a non-standard way, usually through a window.

Of these three categories by far the largest is burns, and within that category the majority of incidents involve chip pan fires. Since these cases comprise such a large proportion of injury-incidents, it is considered worthwhile examining other sources of information relating to their occurrence and characteristics.

The first point which must be made is that in the Present Study, as in all others, data on chip pan fires only exists for those incidents which result in the attendance of the Fire Brigade. What evidence there is suggests that these may represent only a small fraction of the total number of chip pan fires which occur, the majority, presumably, being dealt with by the individual involved. One study, for example, showed that less than 5% of respondents who claimed to have had a chip pan fire actually called the Fire Brigade (Research Services, 1976).

Recent studies of Home Accidents (Roberts et al, 1974; Dept of Prices and Consumer Protection, 1976) have shown that some 24% of the incidents occur in the kitchen, and of these, a large proportion involve burns. Other information (Dept of the Environment, 1974) confirms that fires originating in cooking appliances are responsible for a major, and increasing, proportion of fires in dwellings over the preceding 5 years. This point is clearly illustrated by reference to Table 108 overleaf which shows the percentage contribution of cooking fires to all fires in dwellings. It can be seen that over the period shown, cooking fires have increased by 5772 (56.5%), whilst all domestic fires have increased by 9796 (22.7%).

Preliminary information on more recent fires suggests that in 1973, the absolute number of fires in cooking appliances has risen to 18288, which represents some 33.0% of all domestic fires. If we examine the contribution of fat-fires to this total, we find that these represent nearly 80% of the fires originating in cooking appliances. Reverting to 1972 figures (Dept of the Environment, op cit), it can be seen that of the

TABLE 108. Percentage contribution of cooking appliance fires to all domestic fires, 1968-1972.

Year	Number of fires involving cooking appliances	Total number of domestic fires	% contribution of cooking fires
1968	10212	43072	23.7
1969	11432	45872	24.9
1970	12468	45305	27.5
1971	13745	45955	29.9
1972	15984	52868	30.2

Source: UK Fire and Loss Statistics 1972 (Dept of the Environment, 1974)

15984 incidents involving cooking appliances, some 851 (5.3%) incidents involved a casualty. In 34 cases the injuries received were fatal, and in 935 cases non-fatal. It can thus be seen that in terms of sheer numbers, chip pan and other fat fires represent a considerable problem.

Examination of the chip pan fires discussed in this chapter suggests that often the fires start whilst the people involved are not actually in the kitchen. This finding is supported by evidence from Andrews (1969) in which 58 (88%) of a sample of 66 people who had been involved in chip pan fires said they were absent from the kitchen at the time of ignition.

In the Present Study it was possible in only 5 of the cases involving injury to identify what type of cooker was involved (4 electric, 1 gas). An examination of UK Fire and Loss Statistics for the years 1968 to 1972 shows that the total number of fires involving electric cookers was at least twice that for gas cookers, as is clear from Table 109 below.

TABLE 109.—Fires in dwellings associated with gas and electric cooking appliances, 1968-1972.

Cooker power source	1968	1969	1970	1971	1972
Electric	6816	7696	8507	9512	11305
Gas	3396	3736	3961	4233	4679
Total	10212	11432	12468	13745	15984
Proportion electric/gas	2.00	2.06	2.15	2.25	2.42

Source: UK Fire and Loss Statistics for 1972 (Dept of the Environment,1974)

If we examine these figures in relation to the estimated number of households using gas and electricity for cooking purposes, as shown in Table 110, we can see that the incidence (that is the rate per 100,000 households) of cooking fires involving electric cookers is over four times that for gas cookers.

TABLE 110. Incidence of fat pan fires according to cooker power source, 1973.

Cooker power source	Fat pan fires in dwellings*	UK households using power source	Rate per 100,000 households
Gas	3500	10.8 million	32.4
Electric	10000	7.5 million	133.3
Total	13500	18.3 million	73.8

Source: UK Fire and Loss Statistics for 1973
(Dept of the Environment, 1977)

A number of reasons have been suggested to account for the widely different risk associated with the power source of the cooker and they are listed below.

(a) Control confusion (on electric cookers). Some control knobs can be turned through 360^0 in either directions. As the "stop" on the control wears with use it is possible to turn the knob "through" the "OFF" position to "FULL ON". In addition to this possibility, since electric cookers can be turned "OFF" both at the mains switch (usually on the wall above and behind the cooker), or through individual controls to each ring, it is possible to switch "OFF" at the main switch, whilst leaving the control to an individual ring still in the "ON" position. Any subsequent user of the cooker may inadvertantly activate that ring when switching the main switch "ON".

(b) Audibility and visibility of the flame (on gas cookers). Since gas cooker burners give much stronger audible and visible cues when they are in use, it is thought possible that they are therefore less likely to be left "ON".

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* These figures are obtained by multiplying the number of cooking fires under each power source by the proportion of these fires which can be attributed to fat (80%). Where the power source is unknown, this has been split proportionately between gas and electricity, and added to the total under each heading.

(c) Heat retention (on electric cookers). Once a gas burner is switched "OFF", it does not retain a substantial degree of heat, whereas an electric cooker hotplate does for a considerable time.

(d) Increased heating rate (on electric cookers). More modern designs of electric cookers have much more efficient rings than previous models. The user may be unfamiliar with the more rapid speed of heating and thus leave a pan on it for too long.

(e) Fat spillage. If droplets of fat are spilled when a pan is being heated they can fall through the gas flame without ignition, whereas they will fall onto the hot plate of an electric cooker.

All the above alternatives provide superficially attractive explanations for the occurrence of chip pan fires. There is however no hard evidence to suggest which, if any, either singly or in combination, is responsible.

Examination of the incidents discussed in Section 14.2.1 illustrates clearly that injuries were largely sustained due to the inappropriate actions of the people involved. This aspect has also received attention in an earlier study (Chambers, 1967) which examined the methods used in dealing with chip pan fires. Briefly, he found that the risk of sustaining injury is greatly increased when the pan of hot fat is handled directly. To quote from this report "... the action which stands out as completely inappropriate is removal of the pan out of doors. Although the fire is usually prevented from doing much damage to the room, 15 fires dealt with in this way resulted in six serious injuries (out of only eight injuries identified in the whole study)". This report was based upon 100 cases.

In summary, it is likely that the injury-incidents which can be identified as chip pan fires in the Present Study represent only a small proportion of the total number of chip pan fires within the Study Sample. They are a result of the individual choosing the most inappropriate method of dealing with the fire, attempting to move the burning pan. Indeed evidence from non-chip pan incidents considered in this chapter suggest that we can generalise with some certainty, that this type of behaviour is not only ill-advised for chip pans, but for any type of burning object, be it a bed, a TV set, a paraffin heater, or any other superficially portable item.

For those incidents which involve smoke inhalation received on returning into the building, it seems likely that they could, with only very slight changes in the circumstances, have had much more serious consequences. Whilst such behaviour in attempting to rescue a child is completely understandable to most people, in the case of attempts to rescue pets, it is perhaps a reaction which is peculiar to a nation popularly supposed to be "animal lovers". Only a cross-cultural study could test this hypothesis.

CHAPTER 15

QUALITATIVE EXAMINATION OF INCIDENTS INVOLVING FIRE BRIGADE RESCUES

15.0 QUALITATIVE EXAMINATION OF INCIDENTS INVOLVING FIRE BRIGADE RESCUES

At only 15 incidents, fires from which people were rescued by Fire Brigade personnel are only a small percentage of the total incidents. Four-fifths of these incidents are in the general category of "Dwellings", and nine of these are in the specific categories of blocks of flats, multi-occupancy dwellings or flats over a shop. The remaining, non-dwelling fires, occurred in a Hotel (Incident 66, which has already been discussed in Section 14.1), a Factory (Incident 884, which also involved a fatality, and will be discussed in Chapter 15) and a Boiler House. Since rescues from dwellings predominate in the Present Study we will confine the discussion here to this general category of building.

15.1 RESCUES FROM ONE OR TWO-STOREY DWELLING HOUSES

As mentioned above, all but 3 of the 12 "Dwelling" fires were in some form of flat. Of these three, 2 occurred in two-storey dwelling houses and 1 in a single-storey house. The incident in the bungalow is somewhat anomalous, and the circumstances are outlined below.

(i) Incident 128

The fire occurred at 1923. The interviewee, a girl of 15, had been left alone in the single-storey dwelling by her parents. When she discovered the fire (which she thought was "extremely serious") in the living room, she immediately closed the living room door and telephoned her parents. She then quickly left the house with the dog. She had not actually telephoned the Fire Brigade; her parents were doing this. In the period whilst she was outside, her parents telephoned her again. Guessing it was her parents, she re-entered the building to answer the phone. (As she stated when asked why she had returned into the building, "... phone rang ... required to hear parent".) By this time the fire had developed and in the smoke she became disoriented, and had to be rescued by the Fire Brigade who had now arrived.

It is clear that the rescue of this girl only became necessary because (a) her parents rang her back, and (b) she felt impelled to answer the phone knowing it was them. It is possible that she had not communicated to them just how serious the fire was (objectively it was quite a severe dwelling fire, requiring 1 Jet and having a Fire Severity Index of 16), although this seems unlikely as she not only rated the fire as "extremely serious" but once she had telephoned them, had in her own words "ran out of house with dog". It may be that her parents were merely ringing to reassure the girl that the Fire Brigade were on their way. We can of course only speculate on the content or intent of the telephone conversations; however the girl's return into the building prompted by the ringing of the telephone could easily have led to her demise, as the smoke was extremely dense (estimated at "7" on the Fire Brigade scale).

The remaining two dwelling house fires both occurred at night-time although one was in the late evening and one was in the early morning. Both involved children under 12. They are briefly described below.

(ii) Incident 120

This fire started at 2233 on the ground floor of a two-storey dwelling. A woman of 40 and her four children under 12 were upstairs in the bedrooms. The mother first became aware of the fire by hearing noises associated with fire, and immediately thought it was "extremely serious". It proved to be a 1 Jet fire and the Fire Severity Index was calculated at 14.

She ran to the children in the bedrooms, opened a window to shout for help (presumably in her own bedroom because she then stated that she "went back to the children"). All five of them were rescued by Fire Brigade ladder.

(iii) Incident 932

This fire started at 0507 on the first floor of a two-storey dwelling house. A man of 47, his 46 year old wife and their two children of under 12 years of age were upstairs. The account given by the man has some strange features. For example, he thought the fire was "not at all serious", yet the first thing he did was "... made for front door". He then "went back to (the bedroom)" and "picked up a child". His wife, who thought the fire "quite serious", "got up out of bed, ... looked for children ... and put on dressing gown". All four were subsequently rescued by the Fire Brigade from a fire which required 1 hose-reel to extinguish it. The Fire Severity Index was calculated at 12.

The account given by the woman in Incident 120 seems open to relatively easy interpretation. She became aware of the fire which she (accurately) assessed as extremely serious. (This impression must have been reinforced by moving into smoke through which she estimated she could only see 2 yards.) She realised she could not get all four of the children downstairs and did not attempt to do so, but instead made efforts to get help by shouting from the window.

The evidence from Incident 932 is much more puzzling. One can only interpret the husband's immediate action in an unfavourable light, although this is redeemed by his subsequent behaviour. Otherwise we have too little information available to sensibly discuss this incident.

15.2 RESCUES FROM FLATS

The 9 flats in which Fire Brigade rescues occurred were all of 3, 4 or 5 storeys. None of them had lifts. There is considerable similarity between the circumstances of the rescues in these fires, and four incidents have been selected for brief discussion as being representative of this group. Two of the fires occurred in the morning, and two at night.

(i) Incident 10

This fire occurred at 0709 on the ground floor of a four-storey block of flats. It required 1 Jet and the Fire Severity Index was calculated at 18. Of the 12 occupants, 4 were rescued by the Fire Brigade, 2 of them being among the 6 people interviewed.

Three of the interviewees were on the ground floor: a 29 year old woman who was in her flat with her young child, a 26 year old man and his 24 year old wife. The two young children of the latter couple were also in the flat. The actions of these three interviewees were very similar. All thought the fire was "quite serious". All collected their children and immediately left their flats and went out into the street, moving through smoke with visibility of only 2 yards. Once in the street, the husband asked a passer-by to telephone for the Fire Brigade.

The fourth person interviewed was a man of 60, who was in his first-floor flat with his wife. He also thought the fire was "quite serious" and briefly described his actions as "... dressed in a hurry, went to window". He did not leave the building, giving as his reason that he thought he would be safer where he was, neither did he attempt to move through the smoke.

The two interviewees who were rescued (together with their two young children) were in a flat on the second floor. They both thought the fire was "extremely serious". The husband (24) wakened his wife (23) and children, and they all tried to leave the flat. At the front door of the flat, however, they were turned back by the dense smoke (estimated visibility "0" yards), so they did not leave the flat. Instead they went to the front window and awaited rescue by the Fire Brigade. They were all evacuated from the building by hydraulic platform.

(ii) Incident 12

This fire occurred at 0902 on the second floor of a five-storey multi-occupancy dwelling. Of the 20 occupants, 3 were rescued by Fire Brigade personnel, all 3 being among the 6 people interviewed. The fire required 1 Jet and the Fire Severity Index was calculated at 15.

Three of those interviewed were on the same floor, a 15 year old girl, her 35 year old mother and her 65 year old grandmother. All were in the same flat. It appears that the other person in the flat (sex unknown, but not a relative) was smoking in bed, which caught fire. The mother heard shouts, and on discovering the burning bed shouted to warn the person. She then filled the bath with water which she then threw over the bed. Meanwhile her daughter had been sent by her grandmother to telephone for the Fire Brigade. None of them left the building, although the mother and grandmother attempted to move through the smoke and were turned back (visibility estimate "0" yards).

The three rescuees were on the third floor, the floor above the fire. One of them, a man aged 42, was attempting to leave the building when the Fire Brigade arrived. He had moved some 15 yards down the stairs, through smoke in which he could see 2 yards, when he was met by a Fireman ascending the stairs. He was taken downstairs by the Fireman who told him to "stay outside".

The second man (27) opened the door of his flat but was immediately turned back by the dense smoke (visibility estimate "0" yards) after venturing only 2 yards. He returned to his room which he then left by way of a window onto a flat roof, and waited there until the arrival of the Fire Brigade. He was rescued by Fire Brigade ladder.

The third person, a man of 72, made no attempt to move through the smoke but merely went to the window of his room, which he opened and awaited rescue there. He was also taken to safety by means of a Fire Brigade ladder.

(iii) Incident 7140

This fire occurred at 0237 on the ground floor of a four-storey building. It required 1 Jet and the Fire Severity Index was calculated at 13. The ground floor was used as a Photography shop, with flats on the three storeys above it. The flats were occupied by 6 people, 5 of whom were rescued, including the 1 person who was rescued.

On the first floor was a woman of 74 who smelt smoke but thought the fire was "not at all serious". She first went to get a bucket of water to put on the fire, then went to the open the front door "... as people were banging on it", and finally left the building.

There were two flats on the second floor. One contained a man of 34, his 25 year old wife and their young child. The other flat contained a 32 year old man. In the first flat, the wife was woken by shouts. She then woke her husband who ran to the window and saw flames. They got the child out of bed, the wife wrapping it in a dressing gown, before running down the stairs together and out of the building. In the second flat, the 32 year old man opened his door and saw smoke on the staircase. He immediately ran down the stairs and out of the building. All the second floor occupants estimated they ran 4 yards through smoke in which the visibility was "0 yards".

The sole occupant of the third floor was an 84 year old lady. She also was woken by shouting and thought the fire was "extremely serious". She got out of bed and put on her dressing gown, then opened the door of her flat and tried to get down the stairs. In the process of doing this she collapsed, and was subsequently rescued by a Fireman who had entered the building.

(iv) Incident 688

This fire occurred at 0213 in a three-storey building comprising a Solicitors Office on the ground floor, with two flats above. The fire broke out on the first floor and was not a severe one, no Jets being used and with a Fire Severity Index of only 10. The flats were occupied by 3 people, 2 of whom were rescued. All three were interviewed.

The first person to become aware of the fire was the 20 year old man in the first floor flat. He smelt smoke, thought it "extremely serious", shouted to warn the occupants upstairs, then went downstairs and out of the building. He estimated the visibility through the smoke as "0" yards.

The occupants of the second floor flat were a 34 year old man and a 22 year old woman. The man was awoken by the shouting and woke the woman. They both then dressed and left the flat though a back window, which gave them access to a roof where they then waited for the Fire Brigade. They were rescued by ladder. Although both of them said there was smoke, neither of them attempted to move through it.

15.3 DISCUSSION

Examining these four incidents which, as mentioned earlier, are representative of rescues from flats, one clear, although perhaps very obvious point emerges. That is that the people who are rescued are invariably on floors above the floor on which the fire occurs. Often they are two or more floors above, less often just one floor above. This pattern is very evident where several people were interviewed at the incidents (Incidents 10 and 740 for example). Those on the same floor as the fire, or on the one above, managed to leave the building successfully, whereas those two or more floors above were prevented from doing so by the smoke.

It is interesting that often those who successfully leave have to move through smoke which they estimate to be very dense in so doing. In undertaking this action they have obviously made some "calculation", which includes both the thickness of the smoke and the distance they estimate they will have to move through it. Of those on the floors above, many may also be forced to make such a calculation on opening the front door of their flats when faced by thick smoke. There are three outcomes to this. They may immediately reject any thought of going down the stairs, close the door, go to a window and await Fire Brigade rescue. Alternatively they may venture into the smoke, only to be turned back, and return to their flats again to await rescue. Or, thirdly, they may persist in their attempts to leave via the stairs and, in the cases considered here, be subsequently rescued by a Fireman who had entered the building and was commencing a search.

The basis on which individuals make this smoke/distance calculation, and the factors which influence their subsequent decision whether or not they should attempt to leave, is not readily apparent. However, in the cases considered here, the age of the person, the presence of young children and the time of day, do not appear to be determining factors.

One point which should be noted is that in these incidents it was the nature of the smoke, rather than the position of the fire or heat and flames, which prevented successful evacuation and necessitated Fire Brigade rescue. Several of the "Rescue-Incidents" also fell into the category of "Injury-Incidents". In each case the injury sustained was due to smoke inhalation, and in each case the person had elected to move down the stairs into dense smoke.

The occurrence of fires which involve both Rescue and Injury lead one to believe that there was some relationship between the two types of incident. However, in other ways they are really quite different. For example, only rarely do individuals in Rescue-Incidents engage in any form of fire-fighting (even those who are close to the fire and are able to leave the building unaided), whereas in the majority of Injury-fires it is the ill-advised fire-fighting methods which are the cause of the injury. A likely explanation for this, and other differences between the two types of incident, is that in many cases, fires which eventually result in injuries are often discovered soon after they have begun. This has a dual effect in that, firstly, the smoke has not become thick nor spread extensively and, secondly, the fire itself may also appear to be of sufficiently small scale to encourage the occupant to tackle it himself. Whilst we have no hard evidence, the extent of smoke spread and density of the smoke in Rescue-Incidents suggests that the fire may only have been discovered some considerable time after it started. This interpretation is supported by the analysis conducted in Chapter 7, which suggests that not only is the mean Fire Severity Index for Rescue-Incidents considerably greater than the mean FSI for Injury-Incidents (19.1 and 14.0 respectively), but also that the average number of Jets per incident is also slightly higher (0.93 as opposed to 0.68). Thus where incidents involve both a Rescue and an Injury, these would most accurately be viewed as a special category of Rescue Incidents, rather than vice-versa.

CHAPTER 16

EXAMINATION OF A MATCHED SAMPLE OF FATAL & NON-FATAL FIRES

16.0 FATAL AND NON-FATAL FIRES

Our sample of building fires comprises 952 incidents. Of these, 7 incidents involved a fatality. It is obviously of importance to know how these fatal incidents differ from the 945 non-fatal ones. We have already seen from earlier analyses some of the ways in which they are special. For example, all the fatal fires score fairly high in terms of "Fire Severity". Yet other fires, equally severe, do not result in death. One way in which we can examine the question is to "match" our sample of fatal fires with a similar "control" sample of non-fatal ones, and to qualitatively examine the differences. Clearly there are difficulties with this approach. Firstly, our sample of fatal fires is small, and thus we cannot generalise from any findings with a high degree of confidence. Secondly, the range of variables covered in the Present Study, though large, may not have included those variables which would point-up specific differences. Thirdly, we may have difficulties obtaining a close enough match between our "control" group and our "fatal" group. Fourthly, in some cases we have less information about the fatal fires than we would wish because of their very nature, in that participants are less able, or willing, to give information.

Notwithstanding the possible difficulties outlined above, we feel that such an analysis is worth undertaking, especially where the control closely matches the fatal incident. In this way we can highlight at least some essential differences for that particular incident. On examination of the Study Sample it proved impossible to achieve even an approximate match for the single fatal incident in a factory. This chapter is concerned therefore solely with the six fatal fires which occurred in dwellings.

It was decided to attempt to match the "control" and "fatal" samples on eight main variables. These were

(a) Building type
(b) Number of storeys
(c) Floor on which the fire started
(d) Time of day
(e) Number of Jets
(f) Fire Severity Index
(g) Number of people in the building when the fire was discovered
(h) Their position relative to the fire

Even with 945 potential control incidents, it was possible to provide an exact match for only some of the fatal incidents. The variables on which the two samples proved most difficult to match exactly were

(a) Time of day. Where a close agreement between incident times was not available, a broad division into night-time and daytime incidents allowed control and fatal fires to be paired.

(b) Number of people in the building. This difficulty only arose with the one "Flats" fire involving a fatality, in which 15 people were in the building. There were no other "Flats" fires which had a similar number of people and at the same time matched the high level of Fire Severity.

Other differences between the control and fatal samples were fairly minor and will be discussed in the course of examining each incident.

16.1 FATAL INCIDENT 1

This fire occurred in Town A at 0420 in September. The fire broke out on the ground floor of a two-storey dwelling house. One Jet was used, and the Fire Severity Index was calculated to be 13. There were two occupants in the house, a 72 year old man and his 65 year old wife. Both were asleep in bed on the second floor when the fire started.

We have the statement of the man who survived the fire.

(a) He first became aware of the fire on smelling smoke.

(b) As soon as he realised there was a fire he thought it was "extremely serious".

(c) He lived in the building and was completely familiar with its layout.

(d) He stated that his actions were as follows:
"I got out of bed and went downstairs"
"I tried to put the fire out with buckets of water"
"I went next door to call for aid".

(e) He stated that there was smoke, through which he estimated he moved some 20 yards, estimating he could only see 2 yards in front of him. Although he judged the smoke to be so dense, he did not turn back because of it.

(f) He returned into the building during the course of the fire, although we do not know at what stage. He said his reason for so doing was
"To do what I could for my wife".

(g) He had never received any training on what action to take in a fire, although he had previously been involved in a fire incident.

16.1.1 CONTROL INCIDENT 1a

This fire occurred in Town B at 0103 in October. The fire broke out on the ground floor of a two-storey dwelling house. One Jet was used, and the Fire Severity Index was calculated to be 11. There were two occupants in the building, a 58 year old man and his wife (age unknown). Both were asleep on the second floor when the fire started.

Of our chosen variables, this incident matches Fatal Fire 1 very closely indeed. Again we have the statement of the husband.

(a) He first became aware of the fire by hearing noises associated with the fire.

(b) He thought the fire was "quite serious".

(c) He lived in the building and was completely familiar with its layout.

(d) He stated that his actions were as follows:
"I went downstairs and investigated the living room"
"I opened the living room door, saw fire and smoke. I closed it and told my wife to evacuate the building"
"I went to next door neighbour to call the Brigade".

(e) He stated that there was smoke through which he estimated he moved less than 2 yards. He thought that the smoke was thick enough for him to see less than 2 yards ahead. (This was presumably when he opened the living room door.)

(f) He returned into the building, again we do not know at what stage, "... to get more clothing".

(g) He had never received any training, although he had previously been involved in a fire.

16.1.2 DISCUSSION - INCIDENTS 1 AND 1a

These two fires are, as we have stated earlier, strikingly similar. Perhaps it is in the stated actions of the two husbands that we have a clue as to the possible essential differences.

As a first action, both men went downstairs to investigate. In the fatal fire, however, the man then attempted to deal with the fire himself. Although he had rated the fire as "extremely serious", he must have judged (quite erroneously) that it was within the capacity of a 72 year old to deal with. His method of fire-fighting involved water in buckets, so presumably he would have had to go to the kitchen, find a bucket, fill it with water and then carry it to the scene of the fire. He must have made at least two of these trips. All the time he was doing this, the door would be open allowing the fire, smoke and fumes to spread. At some stage he recognised the futility of his fire-fighting action and went next door to call for aid. He does not mention shutting the door, not attempting to evacuate his wife. At 0420 it must have taken some time to rouse his neighbours, again allowing the fire, smoke and fumes to spread. By the time the neighbours and Fire Brigade were alerted, it is likely that his wife had already succumbed to carbon monoxide poisoning.

In contrast, in the control incident, on discovering the fire (and smoke, which he specifically mentions), the man closes the door and gets his wife outside. He makes no attempt to fight the fire, the smoke and flames are contained and no fatality occurs.

This analysis is supported by examination of the Fire Brigade estimates of Smoke Density and Smoke Spread. Although both incidents were judged to have the same density of smoke ("3" on the Questionnaire scale), in the fatal incident the smoke spread to the floor above, whereas in the control incident it was confined to the room of origin.

It is possible therefore that the fatality occurred because the occupant made a serious misjudgement of either the seriousness of the fire or his own capacities. He undertook injudicious and time-consuming fire-fighting actions which allowed the smoke to spread upwards through the house. In addition, he failed to shut the door of the room, exacerbating the danger from the smoke, and finally he failed to ensure that his wife was out of the building in the early stage of the incident.

16.2 FATAL INCIDENT 2

This incident occurred in Town C at 0400 in late September. The fire broke out on the ground floor of a three-storey dwelling house. One Jet was used and the Fire Severity Index was calculated at 13. There were 7 occupants of the building, 4 of whom were interviewed. These were an 81 year old man, his 42 year old son and 40 year old daughter-in-law, and his 18 year old grandson. There were in addition, his wife (age unknown) who died in the fire, and two other grand-daughters under 12 years of age.

The location of the occupants at the time of the fire was as follows. The 81 year old man, his wife, son and daughter-in-law were in bed asleep on the second floor. The 18 year old grandson and young grand-daughters were in bed asleep on the third floor. They all lived in the building and were completely familiar with its layout.

The statements of the participants were as follows:

42 year old son (second floor)

(a) He first became aware of the fire by smelling smoke.

(b) He thought the fire was "extremely serious".

(c) He stated his actions were as follows:
"Woke my wife"
"Roused and evacuated my 18 year old son and two daughters"
"Told my father to get out".

(d) He stated that there was smoke, through which he could see "O" yards and through which he moved 20 yards.

(e) He returned into the building (presumably after the fire was over) "to obtain shoes and clothing for my family".

(f) He said he received training "at least once per month", and he had also been previously involved in a fire incident.

18 year old grandson (third floor)

(a) He was woken by shouts from his father and thought the fire was "extremely serious".

(b) He stated his actions were as follows:
"Jumped out of bed"
"Got dressed"
"Ran downstairs to street".

(c) He also moved 20 yards through smoke, estimating the visibility at "0" yards.

(d) He said he received training "at least once per month" but had never previously been involved in a fire incident.

81 year old grandfather (second floor)

(a) He was woken by his son and thought the fire "not at all serious".

(b) He stated his actions were as follows:
"Ran for garden hose"
"Went round rear of house to gain access to fire"
"Went out to rear garden and then into unaffected area".

(c) He moved 4 yards through smoke, through which he estimated he could see 4 yards. He did not have to turn back.

(d) He returned into the building "... with garden hose to fight fire".

(e) He had never received any training, but had previously been involved in a fire.

16.2.1 CONTROL INCIDENT 2a

This fire occurred in Town D at 0533 in August. The fire broke out on the ground floor of a two-storey dwelling house. One Jet was used and the Fire Severity Index was calculated to be 16. There were 6 occupants of the building, 4 of whom were interviewed. These were a 75 year old man, his 75 year old wife, their 34 year old son and 33 year old daughter-in-law. Two grandchildren under 12 years of age were also present.

The location of the occupants at the outbreak of fire was as follows. The two 75 year olds were in bed asleep on the second floor, as was the 6 year old grandchild. The son, daughter-in-law and the other grandchild were in bed asleep on the ground floor. They all lived in the building and were completely familiar with its layout.

The statements of the participants were as follows:

34 year old son (ground floor)

(a) He first became aware of the fire by hearing noises associated with it. He though it was "quite serious".

(b) His stated actions were as follows:
"Raised occupants"
"Tackled fire with buckets of water"
"Completed evacuation".

(c) He moved an estimated 7 yards through smoke, in which he could see 2 yards ahead.

(d) He did not return into the building, neither had he previously been involved in a fire incident. He received training "once per year".

33 year old daughter-in-law (ground floor)

(a) She was woken by noises associated with the fire, and rated it as "quite serious".

(b) Her actions were as follows:
"Phoned 999"
"Evacuated 6 year old child from small front bedroom on first floor"
"Left building"

(c) She moved more than 20 yards through smoke with 2 yards visibility.

(d) She had never received training, nor been previously involved in a fire incident. She did not return into the building.

75 year old grandfather (second floor)

(a) He was woken by his son telling him of the fire, which he thought was "quite serious".

(b) *His actions were as follows:*
"Began to dress invalid wife, and then abandoned attempt"
"Helped evacuate wife"
"Left the building".

(c) He also moved more than *20 yards through* smoke in which he estimated he could see 2 yards.

(d) He had never been involved in a fire incident, however he had received training "once per month" before retiring (presumably 10 years earlier).

75 year old grandmother (second floor)

(a) She was also woken by her son, and thought the fire was "quite serious".

(b) She said:
"I *began to get dressed with* the *assistance* of my husband, until my son said there was not time"
"Was assisted downstairs by husband and son"
"Left building".

(c) Her smoke movements and *visibility estimates were* in accord with those of her husband. She had never received training, nor had she previously been involved in a fire incident.

16.2.2 DISCUSSION - INCIDENTS 2 AND 2a

It will be noted that in this case the control incident does not match the fatal incident quite as closely as in Incident 1. Whilst the fatal fire is in a three-storey dwelling, the control is in a two-storey dwelling. In other respects the pairing is very good. We basically have a man and wife with young children living with aged grandparents in each case. Everyone was in bed when the fires were discovered in the early morning.

What are we to make of the fatal incident? The grandmother who died in the fire is not specifically mentioned by any of the interviewees, although we would expect her to be woken when the son warned her husband. Of the interviewees, three are specifically concerned with warning or alerting others in the house and evacuating. Only the grandfather undertakes any fire-fighting action. Can it have been that he left his (wakened) wife to dress and leave the building whilst he "... ran for the garden hose"? Since the others in the building had been alerted first, they would be in the process of leaving, assuming perhaps that the grandfather and grandmother had left together. By the time everyone was outside (and this must have been some considerable time since the 18 year old took time to dress), the grandmother might have been trapped by smoke on the second floor. Once outside, they might also have assumed that the grandmother was at the rear of the house, again with the grandfather.

In the control incident it is also the son who discovers the fire. As in the fatal case he is concerned with alerting everyone and getting them outside. The actions of the wives also mirror each other, in that both are concerned with the safety of their children. Having woken everyone the son starts to fight the fire, but obviously does not continue to do this for long, since he has time to check that the grandparents are getting out of the building. He must by this time have recognised the seriousness of the fire because he tells them they have not got time to dress, and helps his invalid mother downstairs.

The main differences between the two incidents seem to lie in the actions of the grandfathers, and to a lesser extent that of their sons. In the fatal case the grandfather does not ensure that his wife is out of the building, but instead engages in futile fire-fighting. In the control incident, the grandfather is solely concerned with the welfare of his wife. Neither of them seem to have made an accurate assessment of the fire's seriousness, particularly in the fatal case.

In the fatal case the son is concerned throughout with evacuation; however he seems to have assumed that the grandfather will be getting the grandmother outside. In the control fire the son first warns everyone, then starts to fight the fire, and then goes to check that his parents are in the process of leaving the house. When he finds they are not, he hustles them out. The occurrence of the fatality therefore seems to rest on the inappropriate behaviour of the grandfather, and perhaps a misunderstanding between him and his son.

16.3 FATAL INCIDENT 3

This fire occurred in Town E at 0236 in late October. The fire broke out on the ground floor of a three-storey dwelling house. Three Jets were used and the Fire Severity Index was calculated to be 23. There were three occupants of the building, a 42 year old man, his 40 year old wife (who died in the fire), and their 20 year old son. They were all in bed asleep on the second floor when the fire was discovered. The father and son were interviewed. They lived in the building and were completely familiar wiht its layout.

20 year old son (second floor)

(a) He first became aware of the fire by smelling smoke, and immediately thought the fire was "extremely serious".

(b) His stated actions were:
"Went to investigate"
"Called for father"
After that "he didn't remember what happened".

(c) In fact what happened wasthat the smoke was very thick (he estimated that he could see "0" yards in front of him, and the Fire Brigade Smoke Density rating was a high "6"), and in attempting to leave the room he went into the larder by mistake and passed out.

(d) He had never received training, nor previously been involved in a fire incident.

42 year old father (second floor)

(a) He first became aware of the fire by hearing shouts from his son downstairs. He thought the fire was "quite serious".

(b) He said that he
"Went downstairs to see, then threw coat over fire"
"Pulled out son"
"Went to phone for Fire Brigade".

(c) He moved 4 yards through smoke, estimating he could see "0" yards in front of him. He stated that the smoke became even thicker and he eventually had to turn back because of its density.

(d) He had never received any training, nor been previously involved in a fire incident.

16.3.1 CONTROL INCIDENT 3a

This incident occurred in Town F at 1246 in mid-September. The fire broke out on the ground floor of a two-storey dwelling house. Three Jets were used and the Fire Severity Index was calculated at 30. There were four occupants, a 53 year old man, his 56 year old wife, and their two adult children, a son aged 22 and a daughter aged 24. All lived in the building and were completely familiar with its layout. All were interviewed. All except the mother, who was on the ground floor, were in bed asleep upstairs on the second floor.

56 year old mother (ground floor)

(a) She was first aware of the fire by smelling smoke and immediately rated the fire as "extremely serious".

(b) Her actions were as follows:
"Went upstairs to rouse family"
"Went to telephone to call Brigade"
"Went to knock-up neighbours to assist".

(c) She said she moved 4 yards through smoke, through which she could see "0" yards.

(d) She had never received training, nor been previously involved in a fire incident.

53 year old husband (second floor)

(a) He was woken by hearing shouts and immediately thought the fire "extremely serious".

(b) His actions were
"Knocked on daughter's bedroom door"
"Went back into own bedroom and shut door"
"Tied three sheets together and made escape through front bedroom window".

(c) He tried to move through smoke, an estimated 2 yards through which he could see 2 yards. The smoke became thicker ("0" yards), and he had to turn back because of its density.

(d) He had never received any training, although he had been previously involved in a fire incident.

22 year old son (second floor)

(a) He also was woken by shouts and thought the fire "extremely serious".

(b) He said he
"Shouted to warn rest of the family"
"Dropped down with arms fully extended from back bedroom window"
"Got short ladder to sister's bedroom window".

(c) He tried to move through smoke, again an estimated 2 yards with a visibility of "0" yards. He also had to turn back because of the thickening smoke.

(d) He had never received any training, nor been previously involved in a fire incident.

24 year old daughter (second floor)

(a) She was woken by shouts and noise, and immediately thought the fire was "extremely serious".

(b) She stated that she
"Jumped from bed and slipped a dress on"
"Went into both other bedrooms to look for parents"
"Went to back bedroom window to make escape"

(c) She moved more than 20 yards through smoke, through which she could see "0" yards.

(d) She had never received any training, nor been previously involved in a fire incident.

16.3.2 DISCUSSION - INCIDENTS 3 AND 3a

These two incidents are quite similar, the main difference being that the fatal incident is a three-storey dwelling whereas the control is a two-storey dwelling. In this case the difference may be of little importance, as none of the occupants were on the third floor of the fatal fire. Both fires were very severe for dwelling fires, with three Jets required for each. The control fire has a rather higher FSI, accounted for by the large number of rooms involved. Smoke Spread is similar in each case, being very extensive. The Smoke Density in the fatal incident was estimated higher (at "6") than in the control incident ("3").

In the fatal incident, we again have the strange anomaly of neither the husband nor son specifically mentioning the person who perished in the fire, the wife. What seems to have happened is that the son, on smelling smoke, went downstairs to investigate without alerting either parent. On entering the affected room he found very dense smoke. He managed to shout for his father (either to warn or for help?) and then probably attempted to leave the building through the smoke. He became disoriented, and as we saw entered the larder by mistake and passed out. His father was obviously alerted by the shouts from his son and also went down to investigate. We do not know if the wife was also woken, but in any event she remained in the bedroom. The father must have also found the downstairs room filled with smoke, probably by now filling the rest of the house through the opened door. He must have been aware that his son was in the room, for he entered the room and dragged him from the larder. At this stage the fire must have been fairly localised, albeit producing dense smoke, since the father threw a coat over the burning object. He must have dragged his son into the open-air before going to phone the Fire Brigade. Meanwhile his wife was still upstairs, and she must have died from the effects of the smoke which would have poured from the open door of the affected room.

In the control incident it is the wife who discovers the fire. The rapidity of the Smoke Spread in this incident can be gauged by the fact that she went upstairs to warn the other members of the family, went downstairs to telephone the Fire Brigade (and subsequently to summon assistance), and she was in fact the only person in the incident able to use the stairs to make her exit. In the period of time between being warned by her, and preparing to leave, all the other members of the family found the smoke too thick to move through on the stairs. In the event all three had to leave by upstairs windows, in the husband's case by the apocryphal method of tying sheets together. (Incidentally, it is curious that he specifically mentions "three" sheets, whereas of course beds only have two fitted when they are made up. If his statement is correct, he must have gone to a linen cupboard to extract at least one extra sheet.)

To a greater or lesser extent, all three members of the family who were upstairs seem concerned about the welfare of other members of the family. The son shouts to warn the others, escapes through the window and immediately gets a ladder to rescue his sister. The father knocks on his daughter's bedroom before being forced back to his own room, and with commendable presence of mind, shut the door behind him. The daughter, who appears to have moved the furthest through smoke, did so in ensuring that neither of her parents were trapped in the bedrooms. She then was forced to escape through her own bedroom window.

The major difference between the two incidents appears to be that in the control incident, <u>everyone</u> was warned to leave the building, and in fact the participants were checking on each other to ensure that this was happening. This does not seem to have happened in the fatal incident. The son warned neither of his parents effectively, and was in fact lucky not to have succumbed to the smoke himself. His father does not mention warning his wife, and obviously would be very concerned to discover his son unconscious in the smoke-filled larder. Perhaps this concern for the welfare of his son led him into forgetting that his wife needed alerting to leave the house as well. Even when his son is safe, his next action is not to rescue his wife, but to call the Fire Brigade. Clearly the time involved in these actions contributed to the death of his wife.

In both cases the actions of the person who first discovered the fire may have led to the difficulties of the other people involved, since both appear to have left doors open, allowing dense smoke to spread extensively through the houses. In this respect both incidents could have become multiple fatalities.

One further impression gained from studying the two incidents side-by-side is that the family in the control fire were "closer", more dependent, more socially aware than in the fatal incident. This may, however, be reading more into the evidence than actually exists.

16.4 FATAL INCIDENT 4

This incident occurred in Town G at 1246 in mid-September. The fire started on the second floor of a two-storey dwelling house. One Jet was used and the Fire Severity Index was calculated at 18. There were three occupants of the building, a 21 year old mother and her two children under 12 years of age, one of whom died in the fire. The mother, who was the only person interviewed, was on the ground floor at the outbreak of the fire with the older child. The other child was on the second floor.

The statement of the mother was as follows:

(a) She first became aware of the fire by a combination of smelling smoke and hearing noises associated with the fire. She immediately thought the fire was "extremely serious".

(b) She said that her actions were:
"Shout to passer-by to phone Fire Brigade"
"Attempted to get upstairs to rescue child"
"Came out when pulled back by man attempting rescue"

(c) She tried to move through smoke, an estimated 2 yards with visibility "0" yards. She had to turn back when the smoke became thicker.

(d) She had never received training, nor been previously involved in a fire incident.

16.4.1 CONTROL INCIDENT 4a

This incident occurred in Town H at 0859 in early August. The fire started on the second floor of a three-storey dwelling. One Jet was used and the Fire Severity Index was 10. There were three occupants of the building, a mother aged 29 and her two children, both under 12 years of age. The mother, who was interviewed, was on the ground floor at the outbreak of the fire. Both children were on the second floor.

The statement of the mother was as follows:

(a) She first became aware of the fire by being told by one of her children. She immediately thought it was "quite serious".

(b) Her stated actions were
"Evacuated the children"
"Called the Fire Brigade"
"Awaited their arrival outside".

(c) She said there was smoke, which she did not attempt to move through.

(d) She had never received any training, nor been previously involved in a fire incident.

16.4.2 DISCUSSION - INCIDENTS 4 AND 4a

In all important respects these incidents are again very similar. The two main points of difference in terms of pairing are the fact that the fatal incident involves a two-storey dwelling whereas the control involves a three storey dwelling, and the Fire Severity Index for the fatal fire is higher than for the control. We can, I think, discount the effect of the former discrepancy in this case, since none of the occupants were on the third floor at the time of the fire. The latter difference may be of more importance, although we should remember that both incidents are unusually severe for dwelling fires in requiring one Jet. It is clear, however, that the fatal fire became a more severe fire, involving denser smoke and more extensive Smoke Spread. Both of the incidents involved a young mother, alone in the house with two young children, during the daytime. She is downstairs whilst one or both of the children is upstairs.

To begin with, the actions of the two mothers are virtually identical in intention, although the order in which they do them is reversed. We cannot know if this is significant, although it seems likely that the time taken to shout to a passer-by, before attempting to evacuate the child would not make any real difference. The subsequent actions are determined by the specific fire in each case. In this particular matching of fatal/control, it seems that the behaviour was not a determining factor. Rather, it is likely that the extent to which the fire had developed when discovered may have been crucial. In the fatal incident the fire and smoke must have been very severe by the time the mother was aware of it. Even allowing for taking a little time to shout to someone outside, the period between discovery and attempting to get upstairs to rescue the child must have been very short. Yet she was unable to accomplish the rescue.

In contrast, the mother in the second control incident was told about the fire by one of her children, rather than just hearing noises or smelling smoke. She was thus probably aware of the fire much earlier in its development. She therefore had the time to evacuate the children before smoke or other effects of fire prevented her from doing so. Also, since the fire was discovered earlier, the Fire Brigade would arrive earlier, and prevent it from becoming quite as severe as the fatal incident. The occurrence of the fatality may therefore have simply rested upon the late discovery of the fire, and the subsequent lack of time in which to rescue the child.

16.5 FATAL INCIDENT 5

This incident occurred in Town I at 0900 in September. The fire started on the second floor of a two-storey dwelling house. Two hose-reels were used and the Fire Severity Index was calculated at 16. There were two occupants in the building, a 42 year old woman and a 38 year old man, a friend, who died in the incident. The man was on the second floor, and the woman on the ground floor.

The statement of the woman was as follows:

(a) She first became aware of the fire by hearing shouts. She thought the fire was "quite serious".

(b) Her actions were
"Along to sitting room, passed open door, thought he was coming out"
"Ran downstairs and rang 999 for Fire Brigade but couldn't get through"
"Stayed by telephone, then back upstairs".

(c) She moved 10 yards through smoke, through which she could see 4 yards; the smoke became thicker until she could see "0" yards, when she turned back.

(d) She had never previously been involved in a fire, nor received any training.

16.5.1 CONTROL INCIDENT 5a

This incident occurred in Town J at 1514 in mid-August. The fire started on the second floor of a two-storey dwelling house. One hose-reel was used and the Fire Severity Index was calculated at 13. There were two occupants, a woman aged 45 and her 20 year old son. The mother was on the ground floor, and the son on the second floor. Both lived in the building and both were interviewed.

Their statements were as follows:

20 year old son (second floor)

(a) He first became aware of the fire by smelling smoke and immediately thought the fire "quite serious".

(b) His actions were
"Located mother"
"Closed back bedroom door"
"Phoned Fire Brigade".

(c) There was smoke but he did not move through it.

(d) He had never received training, nor been previously involved in a fire incident.

45 year old mother (ground floor)

(a) She also claims to have been first aware of the fire by smelling smoke. She thought the fire was "extremely serious".

(b) Her actions were
"Phoned Fire Brigade"
"Started carrying carpets and bedding from the house"
"Switched off electricity".

(c) She also did not attempt to move through the smoke.

(d) She had never received any training, nor been previously involved in a fire incident.

16.5.2 DISCUSSION - INCIDENTS 5 AND 5a

These incidents are quite similar on the basis of our selected variables and although the times are different, both are daytime incidents. Both incidents contain puzzling features which make them rather difficult to interpret.

Subsidiary information provided by the Fire Brigade suggests that in the fatal incident, the man discovered the fire and engaged himself in fighting it. He was overcome by smoke and collapsed and subsequently died. The woman went to the room involved (which from subsidiary Fire Brigade information we know to have been used as a second-floor sitting room rather than as a bedroom), past the door through which smoke was coming, and then all her efforts were concerned with contacting the Fire Brigade. This she was not able to do successfully at first (for reasons unknown). The man, therefore, must have been in the affected room for some considerable time before she was able to attempt to go upstairs again. By this time the smoke was so thick that she had to turn back. Although the woman did not check, she states that she thought he was leaving the building.

In the control incident what appears to have happened is that again the man discovered the fire, warned his mother and then went to close the back bedroom door, thus containing the fire and smoke. His mother seems to take up the story from there, phoning the Fire Brigade and then starting to save some of the furnishings. As a final, sensible, action she decides to switch off the electricity.

Although there are anomalies in both sets of accounts, one essential difference is that in the fatal incident, the man decided to fight the fire, whereas in the control incident he opted to contain it by shutting the door. Clearly the fatally injured man made a serious misjudgement of his ability to handle the fire. Once he had collapsed, the smoke spread and delay encountered by the woman in contacting the Fire Brigade meant that he was exposed to the fumes for a long time. In the control incident, neither of the occupants attempted to move through smoke at all, which was confined to the upper storey. Had the son not closed the bedroom door, the mother's actions in removing furnishings might have endangered her life.

16.6 FATAL INCIDENT 6

This incident occurred in Town K at 0457 in mid-October. The fire started in a flat on the third floor of a three-storey block of flats. Two Jets were used and the Fire Severity Index was calculated at 21. There were 15 occupants in the building. We do not know the locations of all of these people, only of the four who were interviewed. These were a 35 year old woman on the first floor, a 68 year old man and 48 year old woman on the second floor, a 26 year old woman on the third floor, and the fatality, a 44 year old man on the third floor. All the occupants were in bed asleep at the time of the fire. All lived in the building and were completely familiar with its layout.

The statements of the four interviewees were as follows:

35 year old woman (first floor)

(a) She was told that there was a fire (informant unknown) and immediately thought it "quite serious".

(b) Her actions were simply
"Stayed in house" and "waited".
In other words she took no active part in the fire, did not leave the building nor move through smoke.

(c) The other occupant of her flat was her husband, who was not interviewed.

(d) She had never received training, nor been previously involved in a fire incident.

68 year old man (second floor)

(a) His first awareness of the fire was when he was "wakened by Fire Brigade entering room window". He immediately thought the fire was "quite serious".

(b) Like the 35 year old woman above, he took no active part in the fire, stating his actions to be
"Got out of bed"
"Stayed where I was in bedroom"
He neither left the building nor moved through smoke.

(c) He had never received training, nor been previously involved in a fire incident.

(d) He was alone in his flat.

48 year old woman (second floor)

(a) She first became aware of the fire by being told, and immediately thought it "extremely serious".

(b) Her actions were as follows:
"Woke son-in-law, went upstairs to waken occupier of flat above involved in fire"
"Went downstairs"
"Phoned Fire Brigade".
She remained downstairs in a neighbour's flat.

(c) She did move an estimated 4 yards through smoke, through which she could see 2 yards.

(d) She had never received training, not been previously involved in a fire incident.

26 year old woman (third floor)

(a) She also first became aware of the fire by being told, and thought it "extremely serious".

(b) Her actions were as follows:
"Checked that young child was OK and removed him downstairs"
"Phoned relatives of occupier of flat"
"Went to downstairs neighbour".
Here she remained as she "... thought it was safe in ground floor flat".

(c) She also moved 4 yards through smoke, through which she could see 2 yards.

(d) She had never received training, nor been previously involved in a fire incident.

(e) In addition to her young child, her parents were also in the flat with her.

16.6.1 CONTROL INCIDENT 6a

This incident occurred in Town L at 0340 in mid-October. The fire started on the third floor of a three-storey block of flats. One Jet was used, and the Fire Severity Index was calculated at 12. There were 40 occupants of the building, 2 of whom were interviewed, a 50 year old woman on the third floor, and her 18 year old daughter also on the third floor.

Their statements were as follows:

50 year old woman (third floor)

(a) She first became aware of the fire by seeing flames and thought it was "quite serious".

(b) Her actions were
"Threw a bowl of water at fire"
"The smoke was so bad that I left the flat"
"Went to friends' flat across the corridor".

(c) She moved 2 yards through smoke in which she could see 2 yards.

(d) She had never received training, nor been previously involved in a fire incident.

18 year old daughter (third floor)

(a) She was first aware of the fire by being told (by her mother). She thought the fire was "quite serious".

(b) She "was told to go to friends'flat across the corridor", which she did, and did not thereafter take an active part in the fire.

(c) She did not move through smoke, had not received training, nor been previously involved in a fire incident.

16.6.2 DISCUSSION - INCIDENTS 6 AND 6a

In terms of our selected variables the two main differences between these incidents are, firstly, the fatal fire is a more severe fire than the control fire, and secondly, the number of occupants in the control incident is more than twice as great. This latter point is probably not critical; however the former almost certainly is, and together with the fact that such a small proportion of the people involved were interviewed in each case, we have a much less complete picture of the fire than in the earlier paired incidents. Unfortunately, the control incident was by far the closest match of all the other non-fatal fires in flats. However since it does differ in at least one substantial way from the fatal incident, we will keep the discussion brief.

A number of interesting points arise from both incidents. In the fatal incident both the 35 year old woman and 68 year old man were seemingly prepared to remain in their rooms, even though this was really quite a severe fire. (Smoke Spread, for example, was very extensive.) The man particularly seems to demonstrate the ultimate in composure, not least by the fact that, although wakened at 0500 by a Fireman climbing through his bedroom window, he considers the fire only "quite serious"!

Turning now to the 48 year old woman on the second floor, and the 26 year old woman on the third floor, they both behaved in what seems a very sensible and calm manner, being largely concerned with moving themselves and others to places of safety, and also warning other people.

In contrast with earlier considered pairings of fatal/control fires, in this case it is the occupant in the control fire who undertakes fire-fighting action. Unfortunately, we do not know what was actually on fire; however the action of throwing a bowl of water on it was obviously ineffectual and the woman had to leave the flat. It is interesting to note that no-one mentions calling the Fire Brigade, although presumably the neighbours may have done this.

There are few conclusions we can draw from these two particular incidents. If anything, the behaviour of those interviewed in the fatal fire is more responsible than of those in the control fire. We simply lack sufficient information to interpret and compare the incidents fully.

16.7 DISCUSSION

In 1971, the year in which the Present Study was conducted, the number of fires reported in dwellings was 45,955, of these incidents 506 involved fatalities. Thus some 1.10% of fires resulted in fatalities.

In the Present Study, dwellings accounted for 598 of the incidents reported, and 6 of these fires involved a fatality. Thus 1.01% of the dwelling fires resulted in fatalities. It would therefore seem that the Present Study sample of dwellings has virtually the same incidence of fatalities as all dwelling fires. However it should be recalled that the Present Study utilised only 12 Fire Brigades in the data-gathering, which lasted for a period of only six months. On this basis therefore, fatal incidents are over-represented in the Present Study sample of dwellings.

What we have attempted to do in this chapter is to try to match incidents in terms of some of the "physical variables, so as to examine how differences in behaviour may affect the occurrence of a fatal fire. We have seen earlier (Section 7.5) that fatal fires are, on average, much more severe, both in terms of the number of Jets required and Fire Severity Index, than most other dwelling fires. This of course renders the task of pairing fatal/non-fatal incidents very difficult. The extent to which we were successful in this pairing can be judged by examination of Table 111 which summarises this information. It will be noted that in only two control incidents (numbers 2 and 3) did we equal, or exceed, the fatal incident FSI. In two others (numbers 1 and 5), the difference in FSI is probably not important. However in incident 4, and definitely incident 6, the degree of difference might be considered to invalidate the comparison.

Leaving aside these latter two incidents for a moment, of the four incidents which appear to permit valid comparison, to what extent may we consider behaviour to have played a significant role?

Examination of the Discussion of these incidents shows that in each case, the manifest behaviour of the participants differs in at least one important respect which may account for the different outcomes. We can illustrate this by assigning "positive" and "negative" labels to the various actions and summarising them in tabular form (see Table 112, p.306). We have assigned "positive" labels to all those actions which would contribute to the safety of life, and "negative" labels to those actions

TABLE 111. Comparison of Fatal and Control incidents on the selected Control variables

Incident number	Building type	Number of storeys	Floor of fire	Time	Number of Jets	FSI	Number of people
Fatal 1	Dwelling	2	Ground	0240	1	13	2
Control 1a	Dwelling	2	Ground	0103	1	11	2
Fatal 2	Dwelling	3	Ground	0400	1	13	7
Control 2a	Dwelling	2	Ground	0533	1	16	6
Fatal 3	Dwelling	3	Ground	0236	3	23	3
Control 3a	Dwelling	2	Ground	0538	4	30	4
Fatal 4	Dwelling	2	First	1246	1	18	3
Control 4a	Dwelling	3	Second	0859	1	10	3
Fatal 5	Dwelling	2	First	0900	2(hr)	16	2
Control 5a	Dwelling	2	First	1514	1(hr)	13	2
Fatal 6	Flats	3	Third	0457	3	21	15
Control 6a	Flats	3	Second	0340	1	12	40

TABLE 112. Summary of "Positive" and "Negative" Actions for Fatal and Control Incidents 1, 2, 3 and 5.

Incident number	Positive actions	Negative actions
Fatal 1		(i) Fire-fighting (ii) Failure to warn others (iii) No attempt to evacuate others
Control 1a	(i) Close doors (ii) Evacuate others	
Fatal 2	(i) Warn others (ii) Evacuate others	(i) Fire-fighting
Control 2a	(i) Warn others (ii) Evacuate others (iii) Check evacuation (iv) Contact Fire Brigade	(i) Fire-fighting
Fatal 3	(i) Rescue others (ii) Contact Fire Brigade	(i) Fire-fighting (ii) Failure to warn others (iii) Left doors open
Control 3a	(i) Warn others (all) (ii) Contact Fire Brigade (iii) Shut doors (iv) Rescue others	(i) Leave doors open
Fatal 5	(i) Try to contact Fire Brigade	(i) Fire-fighting
Control 5a	(i) Warn others (ii) Close doors (iii) Switch-off electricity	(i) Save effects

which would have the opposite effect. Since all the incidents were quite severe, we consider all fire-fighting to be injudicious and it is therefore assigned a negative label.

It will be noted from Table 112 that the "errors" may be of commission or omission. Thus "fire-fighting" is an error of commission whilst "failure to warn others" is clearly one of omission. Even where fatal and control incidents contain the same errors, the situation is changed by some additional action in the control incident. Two examples of this can be found in Incident 2a, the act of checking evacuation, and in Incident 3a, the warning of all others.

Turning finally to Incidents 4 and 6, the critical factor here may well have been independent of the behaviour of the participants. In both cases it seems likely that the fatalities occurred primarily as a function of Fire or Building variables. In the former, smoke of high density ("6") spread to the floor above, whilst in the latter smoke of density "5" spread even more extensively through the building. Together with perhaps, late discovery of the fire, and rapid fire-spread, insufficient time may have been available for any differences in behaviour to be critical.

CHAPTER 17

CONCLUSIONS

17.0 CONCLUSIONS

It is unfortunate that a problem such as behaviour in fires falls in the uneasy area where the majority of lay people have an opinion on what they, or others would do in a fire situation, and yet there is virtually no scientific evidence to refute or support these opinions. Even those who are most intimately involved, Fire Brigade personnel, cannot hope to have a comprehensive picture of fire behaviour. In many cases (some 54% in the Present Study), occupants will leave the building before the Fire Brigade arrives, and any subsequent questions will be centred on how the fire started rather than what individuals did. Nor, of course, are Firemen any less susceptible than the rest of us to being capable of remembering only the more unusual or lurid incidents, and assuming that these are typical.

There are two points we wish to make from the above discussion. Firstly that the research described in this thesis must be regarded as exploratory, and secondly that it is very difficult to initially approach the problem without preconceptions concerning what people will do and what factors will influence their behaviour. Inevitably these two considerations will be reflected in the strategy adopted and the variables included in the Present Study.

The theoretical framework on which the work was based is extremely simple. It is assumed that people will be threatened by a fire situation. Fires will differ in the degree to which they pose a threat dependent upon their nature and the characteristics of the building in which they occur. People differ in their susceptibility to be threatened and in their perception of threat. The behaviour undertaken will be based primarily upon the need of the people concerned to reduce the level of threat which they feel, and will differ dependent upon the factors outlined above. In the Present Study, four types of variables were included: Fire, Building, Personal and Behavioural. The underlying assumption is that the first three contain measures of the threat itself, perception of threat and susceptibility to be threatened, which in turn will be associated with differences in the fourth, behaviour. This may be considered a somewhat mechanistic view; however it must be borne in mind that conceptual models and variables studied are inevitably governed by the type of data which is capable of being collected. As has been clearly demonstrated in the present case, the level of information obtained was very much constrained by the data collection method. It will be recalled that the original intention was to collect in-depth information on a small sample of incidents. Had this proved a feasible method, then the overall model and the variables studied would have been rather different. In the event, of course, a much larger scale, less detailed study was eventually undertaken. It would however have been unrealistic to have expected to gain insight into peoples' personalities, motives, thoughts, fears, confusions, emotions and so forth, during the course of the 10 minute interviews conducted by Fire Brigade officers at the scene of the fire which constitute the major part of the data in the Present Study. In retrospect we feel it could be convincingly argued that the original research strategy was in any case incorrect, on the basis that exploratory research of this type should concern itself with providing information on how people behave in fires, before attempting premature explanations of why they behave in certain ways.

In addition to the large sample of fires, we have of course looked in some detail at a sub-sample of incidents, those involving rescues, injuries or fatalities. However, even for this detailed study, its value is further enhanced by virtue of the fact that it was conducted in the context of the large-scale study. As a result of this we have been able to compare across RIF and Non-RIF samples on many variables, and to explore what characteristics distinguish these unsuccessful responses to fire.

Having established the underlying philosophy, we may make our concluding comments on five aspects of the study, the representativeness of the sample, the validity and reliability of the study method, the main findings from the study, the methods of analysis utilised and the indications for further research.

17.1 THE STUDY SAMPLE

The plain fact is that we cannot directly establish how representative our sample is, for the simple reasons that for none of the parameters we might choose, the incidents, the nature of the fires, or the occupants, do we have an established population with which to compare. Thus any attempts at assessing the validity of the sample must be by indirect means.

In essence, the primary sampling measure was "incidents", that is, fire incidents which occurred in buildings, attended by the Fire Brigade, in which people were involved. As we have discussed in Chapter 5 there is no equivalent breakdown of official statistics on fires, the nearest being "Fires in Buildings". It is clear that the category "Fires in Buildings" will contain some unknown proportion of incidents in which people are not involved. Furthermore, it is likely that these incidents (those not involving people) will be unevenly distributed between building categories. For these reasons, we would suggest that the apparent preponderance of Dwelling fires in the sample may not in fact indicate a bias in our sample of incidents, but simply reflect the fact that Dwelling fires are more likely to involve people than fires in other types of occupancy.

Whilst not conclusive, the evidence from comparing the time of the incident between the Present Study and "Fires in Buildings" tends to support this conclusion. In this comparison "Fires in Buildings" differ from our sample in having an excess of evening and a paucity of morning fires, just the times at which we would predict that Non-Dwellings would be more likely to be empty of, and contain people, respectively.

At first sight, it may also appear that the Present Study contains an over-abundance of "small", Low severity fires. For example, only 28% of the incidents required Jets to extinguish them. There are four points which should be made concerning this aspect. Firstly, the original brief for the study was to examine behaviour in a broad range of fires, and these incidents therefore have a rightful place in the study. Secondly, because only those incidents which are unusual in some way, such as very large fires or multiple fatalities, are given publicity, we tend to assume that such incidents are the norm, whereas it is likely that the vast majority of fires are indeed quite minor and relatively unimportant in terms of their effect on the community. Thirdly, all the incidents in the sample were attended by the Fire Brigade and were therefore considered severe enough by someone to warrant a 999 call, and fourthly, the concept of Fire Severity itself is not a simple one. We have discussed at some length, in Chapters 6 and 7, the variables which were used to assess the seriousness of the fire. It is clear from these discussions that there is no single measure which provides a valid metric for this aspect. Indeed, it is one of the important findings of the study that fires tend to differ in their nature, in terms of Fire Severity variables such as intensity, spread, and smoke characteristics, dependent upon the category of building in which they occur. Furthermore, these factors are not necessarily related, thus incidents which require Jets to extinguish them, implying high intensity of fire, are likely to have low values of Smoke Spread and Smoke Density, and vice-versa.

In the absence of an equivalent population with which to compare the severity of the fires in our sample, we cannot of course know whether it is representative. Again our only potential comparison is with "Fires in Buildings". If we examine the method of extinction for this population, we find that of the 105,328 fires which occurred in buildings during 1972, 17,726 were extinguished using Jets from pumps and hydrants, this figure being only 16.8% of the incidents. Therefore on the basis of the above-mentioned points we feel that the apparent low proportion of incidents on one particular severity measure should not be taken as an indication that it is unrepresentative in this direction. On the basis that fatal incidents, which might validly be taken as a measure of the seriousness of the fires, are apparently over-represented in the sample, it could equally well be argued that we have a preponderance of severe fires.

17.2 THE STUDY METHOD

Having rejected, at an early stage, simulation and direct observation as possible study methods, then a method of "indirect observation" became the only means of collecting information on behaviour in fires. As has been discussed earlier, the particular study method and variables used in this research were determined to a large degree by constraints imposed by the data collection system. The use of Fire Brigade personnel in this role obviously brought many advantages; however we must examine how successful the technique has proved in studying the given problem. A criticism which can be levelled at any work employing questionnaire or interview techniques is that it relies upon what people say they do, rather than measuring what they actually do. Clearly in some studies it is possible to check the validity of questionnaire measures by obtaining some direct observations of the phenomenon. However we have seen that the nature of the fire situation tends to preclude this kind of check. One way of checking the validity of the present data was to require the

Fire Brigade officers who acted as interviewers, to compare the replies given by the respondants with their own first-hand knowledge of the particular incident. By operating this check approximately 3% of the returned forms were rejected prior to analysis. Almost all of these rejected questionnaires were endorsed to the effect that the interviewee was under the influence of alcohol. An additional check on validity was possible after initial coding by checking and comparing the responses of interviewees from the same incident. The average number of people interviewed per incident was slightly over 2, the highest number being 12, so it was quite feasible to examine a fairly large number for possible anomalies which could then be resolved by checking back with the Fire Brigade involved. The performance of the Fire Brigade was of course closely monitored by the investigator throughout the course of the study, and several incidents were attended to confirm correct usage of the questionnaire. In addition to these procedures we feel that the actual nature of the responses lends weight to their veracity, as is borne out by study of the qualitative analyses. There certainly appeared to be little attempt to deliberately put actions in a good light. It seems likely that many of the people who confessed to an inappropriate action were ignorant of the fact that they were so doing.

The reliability of the method may be open to more question. Having defined "involved" in the Introduction, it seems clear that the sample collected is somewhat biased, in that the people interviewed tended to be those <u>immediately</u> involved with the fire. This inevitably follows from the use of Fire Brigade officers, who have only a limited time at the scene of the incident, as data gatherers. If the fire occurred in a large building they they could not possibly hope to interview all the people who were aware of the fire, and they therefore, not surprisingly, elected to obtain information from those closest to the actual scene. However, even a large team of independent interviewers would be unlikely to obtain a complete picture of the incident, as the time demanded by such an exercise, in say a factory containing 200 people, would be quite unacceptable. This possible source of bias should not be over-emphasised, as only 6.2% of the incidents in the sample involved buildings which contained more than 100 people, and in many incidents, particularly fires in Dwellings, all the people in the building were interviewed.

In retrospect, perhaps the least satisfactory aspect of the questionnaire lay in the unstructured questions relating to the courses of action. Although these were arranged to provide sequential responses, the difficulty when analysing the data arises from having no knowledge of the time scale occupied by each action. The length or brevity of the recorded comments did not appear to be related to the duration of the actions, rendering it difficult to assess over what period of time a person continued to pursue any specific action. This was particularly so when the course of action was a general one, directed mainly towards one end, for instance fire-fighting. It may be that the person was fighting the fire for several minutes, but superficially he appears to be less "active" than someone who did several specific things, which may well have occupied less time. It is difficult to suggest how this problem might be overcome, since subjective time estimates, even in non-stress situations, are notoriously unreliable.

17.3 THE STUDY FINDINGS

If we were required to express the findings of the study in one short, alliterative, phrase, the one which would spring most readily to mind is "Dwellings are different". Whilst the phrase in itself may not convey much information without further amplification, it aptly summarises the fact that on each of our Study variables, the overall impression is that the fires, the people, and the behaviour in Dwellings tends to differ from other building categories. Even when we consider interactions between variables, we find that the main effect of occupancy over-rides other factors.

Even outside the fire situation, Dwellings of course differ substantially from other types of building. On the purely physical level they are architecturally different, constructed perhaps in different materials, and containing the wide range of consumer goods which are associated with home living in a developed country in the late 20th century. On a functional level, we could go on to list all those activities which are implicit in the phrase "home living": eating, sleeping, leisure and so on, which set Dwellings apart from other occupancies; however the point is too obvious to labour. At least some of these intrinsic differences are related to the study findings. For example, the nature of the fires in Dwellings is such that they tend to be characterised by low intensity/high Smoke Spread and Smoke Density. It would seem reasonable to explain this in terms of the most common sources of ignition, cooking appliances, children with fire, smokers' materials, and the presence of large quantities of soft furnishings, clothing, etc, in most homes. Together with the relatively small volume of space enclosed within a Dwelling, the absence of self-closing smoke doors and the fact that most Dwelling fires occur during the day, the nature of these fires seems eminently reasonable.

Dwellings are also distinguished by the characteristics of their occupants at the time of the fire. On the evidence of the Present Study they were more likely to be female, to rate the fire as more serious, to be completely familiar with the building, to have never received training, to have not had previous experience of fire and to be family members. Several of these associations are of course unsurprising, however they do reinforce the point we are making that Dwelling incidents differ from incidents in other buildings. How are these differences manifest in the behaviour of the occupants? Dwelling occupants seem to adopt a very diverse range of behaviour patterns which often include some action to minimise the risk, such as closing doors or switching-off mains services. They also appear to be very concerned with contacting the Fire Brigade. These patterns contrast with those in Industrial occupancies, where the major concern is fire-fighting, Retail occupancies where it is fire-fighting and contacting the Fire Brigade, and Institutions where warning others and investigating predominate. When looking at the specific actions which people took, Dwellings stand out in having a disproportionately large number of occupants who leave the building, although an exception to this general rule is provided by the occupants of high-rise flats, who tend to leave less frequently than the occupants of low-rise dwellings.

If occupancy is one major determinant of behaviour, then the characteristics of the fire must be considered another. Indeed if we consider factors which increase evacuation of the building, the single most important main effect is that of extensive Smoke Spread. In other respects, our measures of Fire Severity appear to have relatively uniform effects upon the patterns of behaviour, but inconsistent effects upon specific actions. We could perhaps have predicted that warning others, evacuating others and evacuating oneself would become increasingly frequent components of the action sequences as the fire becomes more severe. What we would not have easily foreseen, however, was the manner in which fire-fighting, minimising the risk, and in particular, contacting the Fire Brigade, all appear to be associated with the lower levels of Fire Severity. A possible interpretation for this finding might be that when the fire is less serious, the actions of the occupants are largely "fire-oriented", that is, their major concern is to minimise the consequences of the fire in terms of damage, extent and expense. In more serious fires, however, there is a switch from "fire-oriented" to "safety-oriented" behaviour, in which the major concern becomes the personal safety of the occupants, and the material damage assumes a much less pressing concern.

Over the course of the incident, increasing Fire Severity as measured by all our variables, acts uniformly to increase the proportion of people leaving. As we have seen, the extent of Smoke Spread is the single most powerful determinant for this action. Returning into the building also appears to be more closely related to smoke characteristics than other severity measures, in this case of course, high levels of smoke variables tending to discourage re-entry. Assuming that the relatively large numbers of people who move through smoke when it spreads extensively simply reflects the greater exposure; it is the density of the smoke which appears to have the greatest deterrent effect. It is clear therefore that whilst any of our measures of Fire Severity may be seen to affect behaviour, it is the characteristics of the smoke which have the strongest and most uniform action.

The third important factor determining behaviour is the group of variables which we have chosen to describe as Personal variables. In a way, this set of variables lacks homogeneity, encompassing as it does "true" Personal variables such as sex and age, "experiential" variables such as training and familiarity, "incident-related" variables such as first awareness of the fire and seriousness rating, and "social" variables such as the presence and relationships of others in the building. Despite these essential differences in the nature of the variables, one can often discern a consistent thread in terms of their effects upon behaviour patterns. For example, the factors which appear to increase the likelihood of an individual attempting fire-fighting include training and previous experience of fire, the absence of family members, and men as opposed to women. All these factors tend to be associated with a particular occupancy, Industrial category buildings, so we are to a large extent confirming the already-noted relationship between fire-fighting and Industrial buildings. Similarly, contacting the Fire Brigade is more frequent for people who are completely familiar with the building, who are untrained, inexperienced in fire and alone in the building, in this case an outline more closely related to the occupants of some Dwellings. It is of interest that the effect of subjective perception of increased fire seriousness lends support to our earlier hypothesis concerning behaviour patterns changing from "fire" to "safety" oriented, in this case even to the extent of suppressing the powerful initial need to investigate the fire. In the majority of cases, "investigating" the fire is the most frequent First Action and as we have earlier commented, behaviour patterns are perhaps of more interest when investigating is not the very first action made. This occurrence appears to be associated with quite specific factors such as previous experience of fire, training and a particular age range, 41 to 50 years. It is also notable in incidents where no other people are present in the building, to some extent in Industrial fires, and to a rathermore obvious degree in Institution fires. It is clear from the above that this behaviour pattern, unlike fire-fighting and contacting the Fire Brigade, is not related in a simple way to a particular building category, but may also be associated with particular "types" of people.

For the specific actions, evacuation, re-entry and movement through smoke, the most clear-cut findings in terms of the effect of Personal variables relate to evacuation. A list of those factors which increase the number of people leaving: absence of training, inexperience of fire, presence of family, increasing age, perception of increased fire seriousness, women rather than men, suggests that yet again we are describing the characteristics of a particular population of building occupants, in this case Dwellings.

If in the foregoing discussion we have emphasised the effect of occupancy in interpreting behaviour, and in particular the specific case of Dwellings, consideration of those incidents which involved Rescues, Injuries and Fatalities serves to confirm this impression. As we have noted, these incidents are much more likely to occur in Dwellings than in other types of building, the other major distinguishing feature being that they are in general more serious, on all our measures of Fire Severity, than Non-RIF incidents. This particular group of incidents was selected for more detailed study on the basis that they represent an "unsuccessful" response to fire. Evidence from the qualitative analyses leads us to the conclusion, however, that whilst Rescue and Fatal incidents share many similarities, Injury incidents tend to differ from both in many respects. Perhaps the most important distinction arises from the extent to which behaviour plays a part in determining the unhappy outcome. In general we would suggest that the occurrence of injuries at a fire incident is largely "behaviour-dependent", whereas at least a proportion of the Rescue and Fatal incidents appear to be "behaviour-independent". The largest single cause of injuries was of course inappropriate handling of chip pan fires, although this conclusion should perhaps be expressed in a more generalised form as inappropriate attempts to move the burning object. In contrast to those involved in Rescue incidents, these people are, using our terminology, to a large degree "fire-oriented", and it may be of significance that of all the RIF incidents, Injury incidents had the lowest Fire Severity values. Whilst we may only conjecture on the underlying reasons for embarking on this type of response, its demonstrated inappropriateness must suggest a clear need for more effective education on this aspect.

We have suggested that the occurrence of both rescues and fatalities is to a certain extent independent of the behaviour of the occupants, however this is more clearly true of Rescue incidents than of Fatal incidents. In most Rescue incidents, the extent and density of the smoke on first discovery of the fire are such that the only variations on behaviour are whether to attempt to leave the building by an unorthodox route, to remain in the room and await rescue, or to attempt to move downstairs through the smoke. The last of these alternatives must in general be the most hazardous, although in our sample of incidents the outcome for all three was the same, rescue by Fire Brigade personnel.

The number of Fatal incidents arising in the study was inevitably small, nonetheless, we feel that some general conclusions may be drawn from them. In at least 2 of the 6 incidents considered, we would conclude that the particular circumstances and nature of the fire situation were the most important factors. In the remaining 4, comparison of the Fatal incident with one of equivalent severity suggests that the behaviour in them may have been qualitatively different. An overall impression is that the occupants in the Control incidents were in general more concerned for the safety and welfare of those involved. Looking specifically at comparisons between the behaviour patterns, it is clear that the responses to similar fire circumstances may either differ completely, or may in fact contain several common elements. Where there is complete divergence in behaviour we find that the occupants in the Control incident were concerned almost exclusively with the safety of life, whilst those in the matched Fatal incident divided their efforts between the fire and the other people in the building. Where Fatal and Control incidents contain common actions, the difference in behaviour shows as some additional response on the part of the occupants in the Control incident, which in the cases examined prevented a fatal outcome.

17.4 METHODS OF ANALYSIS

Our conclusions regarding the analysis of the data are brief. Whilst many multi-variate techniques are now available, it was considered that the nature of the data was more suited to simple methods of analysis. The reasons for this were three-fold. Firstly, it was not necessary to make unwarranted assumptions about the level of measurement or distribution of the variables. Secondly, a preliminary analysis using Factorial techniques suggested that the variables were related in simple, rather than complex ways, and thirdly the interpretation of the findings is rendered more simple if it is analysed in the way we have undertaken. We are not of course suggesting that other facets of the data could not be revealed by more sophisticated techniques, but merely that the findings presented earlier are the major associations between the variables.

By analysing the data on general behaviour in terms of sequences of actions, it can at first sight appear rather complex, especially when broken down into several samples. Yet in fact we are providing a very much simplified view of what happened. Behaviour is a process, not a thing, and the seeming complexity of the behaviour patterns reflects our natural tendency to reduce complicated phenomena to simple forms which are easy to grasp. We feel that, whilst in some cases this form of analysis did not reveal the gross differences in responses we might have expected, it is nonetheless the most valid way of handling this particular information.

17.5 FUTURE RESEARCH

Under this heading we want to draw both a general and a specific conclusion. The Present Study was based upon a large scale quantitative examination of behaviour in a range of fires, and a small scale qualitative examination of behaviour in incidents involving rescues, injuries or fatalities. It is clear that even our detailed examination of this sub-sample of fires does not explore in sufficient depth the motives for and determinants of behaviour patterns. Our general conclusion therefore must be that any future research in this area should concentrate on a detailed, qualitative study of behaviour in fires. The evidence from the Present Study suggests that the qualitative aspects of the variables may in fact be of considerable importance. Several examples come to mind, for instance the measure of fire training. In the present case we utilised a simple measure of training frequency, however this is clearly inadequate to interpret differences in manifest behaviour, and it is likely that the nature and specificity of the training received are of at least equal or greater importance. A similar argument applies to previous experience of fire, for which the nature of this experience and the elapsed time since its occurrence must be considered relevant. In respect of the duration over which behaviour lasted, we would hope that a more detailed examination would provide much needed information. Certainly one difficulty which arose from the Present Study was in requiring interviewees to relate their actions to "the course of the incident", which is obviously open to widely different interpretations. The motives for behavioural responses were explored only in a very generalised way. The reasons why individuals left or returned into the building, and the intentions of those who moved through smoke, could not be closely determined within the scope of this study, and can only be explored by a smaller scale qualitative study.

The specific conclusion relates to those incidents which involved cooking fires, in particular chip pan fires. It is clear that even though we are relying only on data from incidents attended by the Fire Brigade, these are a considerable problem, and represent a drain on both medical services and material resources. We would conclude therefore that they warrant a major effort in research.

The objectives of this research would be as follows:

(a) To identify the true incidence of these fires and their consequences.

(b) To identify the differences, in terms of both behaviour and equipment, between incidents which are dealt with successfully and those which are not.

(c) To derive preventive measures, which might be modified products or educational measures, to reduce the incidence of cooking fires.

It is likely that the realisation of these objectives would require a series of investigations, which would include a large scale control study, small scale in-depth studies of incidents, field studies of user-behaviour and laboratory user-trials and evaluation.

APPENDICES 1-8

APPENDIX 1

Estimating procedure for the number of people involved in fires in dwellings per annum.

All figures relating to population are extracted from Central Statistical Office (1970)

All figures relating to fires are extracted from United Kingdon Fire and Loss Statistics, 1969 (op.cit.)

(i) Number of fires attended by Fire Brigades in dwellings = 46,000 approx.
(ii) Fires in dwellings occuring between 5 p.m. and 9 a.m. = 26,000 approx.
(iii) Fires in dwellings occuring between 9 a.m. and 5 p.m. = 20,000

The average number of people per household = 2.91

If we assume that all members of the household are present between 5 p.m. and 9 a.m., then average number of persons involved during these hours is 26,000 x 2.91 = 75,660

For working hours, 9 a.m. to 5 p.m., we must estimate the average population of a dwelling separately.

To estimate population not in dwellings between these hours,

Total Working Population = 25,200,000
Total HM. Forces = 380,000
Total School children = 9,320,000
Total Institutional Population = 860,000
36,160,000

Total Population = 55,600,000

population in dwellings between 9 a.m. and 5 p.m. = 55,600,00 - 36,160,000
= 19,440,000

Estimated number of dwellings = 19,634,000

average population of dwellings between 9 a.m. to 5 p.m. $= \frac{19,440,000}{19,634,000}$
= 0.99

Average number of persons involved in fires during these hours = 0.99 x 20,000
= 19,800

Total number of persons involved in dwelling fires = 19,800 +
75,660
95,460

APPENDIX 2

Estimating procedure for number of people involved in fires other than dwellings per annum.

Number of fires in buildings other than dwellings per annum = 45,000approx.
Approximately 40% of fires occur between 9 a.m. and 5 p.m., therefore number of fires in buildings occurring in working hours = 18,000
(i) Assume each fire in separate building
(ii) Average number of people per building = 150
(iii) Assume only 10% of people aware of fire = 15
Therefore number of people involved = 15 x 18,000
= 270,000

Total number of persons involved = 270,000 +
95,460
365,460

Probability of being involved in a fire per annum = 365,460/55,600,000
$= 6.5 \times 10^{-3}$

N.B. Estimate of working hours is probably substantially correct for occupancies other than industry. However in the absence of data concerning percentage of industry working shifts, this time-period is also applied for industrial occupancies. It is of course likely to be an underestimate.

APPENDIX 3

REPORT OF FIRE No. K433 (7th Revision—3rd Impression)

*Fire Brigade/Fire service

Call No.

Date and Day of Call

Additional particulars to follow on form K434.* No additional particulars to follow.*

Division, etc. Station

* { For Counties (E. & W.) only—County District (i.e., Non-County Borough, U.D.C. or R.D.C.)
For Scotland and N. Ireland—Administrative Area in which Fire occurred

1. Address of Fire
2. Name(s) of Occupier(s)
3. Trade(s) or Business(es) carried on:

Where fire started:

Where fire spread to:

4. Method of Calling: (a) W.F.B.
   (b) F.B.
5. Discovered by
6. Weather
7. Road condition
8. Wind
9. Time of Discovery
10. Time to Call to W.F.B.
11. Time of Arrival of W.F.B.
12. Time of Call to F.B.
13. Time of Arrival of F.B.
14. Time under control
15. When last F.B. Appliance returned to Station
    (a) Date
    (b) Time
16. Risk Category

1. SUPPOSED CAUSE:

2. PARTICULARS OF PROPERTY INVOLVED: Type No. Approximate date of building construction or manufacture

DESCRIPTION:

3. PARTICULARS OF CONTENTS:

4. EXTENT OF FIRE
   (i) Fires in Buildings.

CONFINED TO { room of origin
floor of origin
building of origin
roof or roof space

EXTENDED TO { adjoining buildings
†separate buildings
other hazards

(ii) Fires other than those in buildings.
CONFINED to hazard in which fire started

EXTENDED TO { †buildings
other hazards

5. DESCRIPTION OF DAMAGE:

6. DEVELOPMENT OF FIRE: Assisted by combustible floor, wall, ceiling, roof lining*

7. SPRINKLERS:
   (i) *Hand operated system installed
   *Automatic system installed
   *Not installed
   { In room or section
   (ii) Failed to operate because
   (iii) Operated, heads being actuated, and (a) *Controlled fire. (b) *Extinguished fire.
   (c) *Did not control fire because

*Delete as necessary. †See separate form(s) K.433 marked

8. FIRE PROTECTION APPLIANCES OR DEVICES OTHER THAN SPRINKLERS OR PORTABLE HAND OPERATED APPLIANCES:

9. METHOD OF EXTINGUISHING THE FIRE:

(i) If tackled before the arrival of F.B. give details (including methods used by Works Fire Brigade):

(ii) Method used by F.B.:

(iii) If immediate water supply was inadequate, give reason and details of any relay brought into operation:

Rescues, Escapes

Name(s)	Sex	Age (years)	Method of rescue or escape	Person effecting rescue

Casualties✱

†Name(s)	Sex	Age (years)	Address(es)	Nature of injury	If injuries prove fatal, cause of death

✱Other than those requiring First-Aid treatment only **†For F.B. personnel add (F.B.) after name**

1. F.B. APPLIANCES:

(Give Fire Brigade (name suitably abbreviated), Division (if applicable,) and Station (number or name suitably abbreviated) from which the appliances attended, followed by the total number of appliances in brackets, e.g., "L.C.C. B. 26 (2)." Relief appliances are not to be included.)

P.E.

WR.T.

PUMPS

T/L. (Mech.)

T/L. (60′ H/O.)

Give particulars of other F.B. appliances:

2. APPLIANCES OTHER THAN F.B.

3. F.B. PERSONNEL above rank of Station Officer† attending before receipt of "stop" message (staff, visiting and relief officers need not be shown). †Note—When the officer in charge of the fire is of Station Officer rank, or below, his name should be entered.

Designation of Station or Headquarters to which attached	Rank	Name

4. TOTAL NO. OF PERSONNEL ATTENDING: (a)Whole-time:— (b) Part-time:—

Signature

Officer in charge of Station

Date

J9 Dd.823737 500m GP 10/71

APPENDIX 3

Behaviour of People in Fires (Pilot Study)

Questionnaire to be completed by Fire Brigade Officer, <u>not</u> the person being interviewed. I
is only necessary to place a tick in the box opposite the appropriate response.

1) Male ☐ 1 Female ☐ 2

2) Under 25 ☐ 1 25 - 45 ☐ 2 45 + ☐ 3

3) How did you first become aware of the fire?

(a) Heard fire alarm ☐ 1
(b) Smelt smoke ☐ 2
(c) Saw flames ☐ 3
(d) Felt heat ☐ 4
(e) Heard shouts ☐ 5
(f) Were told ☐ 6

4) What was your position (within the building) at that time?

(a) On the same floor close to the fire ☐ 1
(b) On the same floor remote from fire ☐ 2
(c) On the floor above ☐ 3
(d) On the floor below ☐ 4
(e) In a room ☐ 5
(f) In a corridor ☐ 6
(g) Don't know ☐ 7

5) What were your immediate feelings?

(a) Unconcern	☐	1
(b) Slight worry	☐	2
(c) Confusion	☐	3
(d) Excitement	☐	4
(e) Fear	☐	5
(f) Desire to escape (move)	☐	6

6) Did these feelings alter during the course of the fire?

(a) Become greater	☐	1
(b) Become less	☐	2
(c) Change completely	☐	3

7) What did you do as soon as you realised there was a fire?

(a) Went to see where it was?	☐	1
(b) Prepared to leave the building	☐	2
(c) Went to warn other people	☐	3
(d) Enquired whether Fire Brigade had been called	☐	4
(e) Attempted to call Fire Brigade	☐	5
(f) Attempt to extinguish it	☐	6
(g) Operated the fire alarm	☐	7
(h) Nothing	☐	8

8) Did you attempt to leave the building?

(a) By your normal route	☐	1
(b) By another ordinary route	☐	2
(c) By climbing through a window	☐	3

9) Did you have any difficulty in moving about due to

(a) Heat ☐ 1
(b) Flames ☐ 2
(c) Smoke ☐ 3
(d) Choking fumes ☐ 4
(e) The actions of other people ☐ 5
(f) None ☐ 6

(If 9 (c), then questions (10) and (11) apply, otherwise omit)

10) How far did you attempt to move through the smoke?

(a) Three feet ☐ 1
(b) Six feet ☐ 2
(c) Twelve feet ☐ 3
(d) More ☐ 4

11) Were you

(a) Walking upright ☐ 1
(b) Running upright ☐ 2
(c) Crouching ☐ 3
(d) On hands and knees ☐ 4

12) How far could you see through the smoke?

(a) Three feet ☐ 1
(b) Six feet ☐ 2
(c) Twelve feet ☐ 3
(d) More ☐ 4

13) Where were you when the Fire Brigade arrived?

- (a) In original place ☐ 1
- (b) Attempting to leave the building ☐ 2
- (c) Outside the building ☐ 3

14) Did you eventually leave the building?

- (a) By your own efforts ☐ 1
- (b) By the efforts of the Fire Brigade ☐ 2
- (c) By the help of others ☐ 3
- (d) Not at all ☐ 4

15) Have you ever been involved in a fire incident before?

- (a) At home ☐ 1
- (b) At work ☐ 2
- (c) In another building ☐ 3

This section to be completed by Fire Brigade Personnel only.

Date :

Fire at :

Number of storeys :

APPENDIX 5

Behaviour of People in Fires in Tall Buildings (Pilot Study)

This questionnaire is to be handled by the Fire Brigade Officer, not the person being interviewed. Except for the brief factual details at the beginning of the questionnaire, it is only necessary to place a tick or a number in the box opposite the most appropriate response.

Address of Incident: ....
....
....

Date and time: ....

Floor of origin ☐☐

Number of floors ☐☐

Fire alarm provided? yes ☐ no ☐

Fire equipment provided? yes ☐ no ☐

---

1) Male ☐ 1 Female ☐ 2

2) Under 25 ☐ 1 25 - 45 ☐ 2 45+ ☐ 3

3) Flat Number ☐☐☐

4) Floor Number ☐☐

5) How did you first become aware of the fire?

- (a) Heard fire alarm ☐ 1
- (b) Smelt smoke ☐ 2
- (c) Saw flames ☐ 3
- (d) Felt heat ☐ 4
- (e) Heard shouts ☐ 5
- (f) Was told ☐ 6
- (g) Were not aware of the fire ☐ 7

6) Which floor were you on when you first became aware of the fire?

Floor number ☐☐

7) What was your position within the building at that time?

(a) In your flat ☐ 1
(b) In the lift ☐ 2
(c) In the corridor/entrance hall ☐ 3
(d) Don't know ☐ 4

8) What what your immediate feelings?

(a) Unconcern ☐ 1
(b) Slight worry ☐ 2
(c) Confusion ☐ 3
(d) Excitement ☐ 4
(e) Fear ☐ 5
(f) Desire to escape (move) ☐ 6

9) What did you do as soon as you realised there was a fire?

(a) Went to see where it was ☐ 1
(b) Prepared to leave the building ☐ 2
(c) Went to warn other people ☐ 3
(d) Enquired whether Fire Brigade had been called? ☐ 4
(e) Attempted to call Fire Brigade ☐ 5
(f) Attempted to extinguish it ☐ 6
(g) Operated the fire alarm ☐ 7
(h) Nothing ☐ 8

10) Did you attempt to leave the building?

(a) By the lift ☐ 1

(b) By the staircase ☐ 2

(c) By climbing through a window ☐ 3

(d) Not at all ☐ 4

11) Did you have any difficulty in moving about due to

(a) Heat ☐ 1

(b) Flames ☐ 2

(c) Smoke ☐ 3

(d) Choking fumes ☐ 4

(e) The actions of other people ☐ 5

(f) None ☐ 6

(If 11(c) is ticked, then questions 12), 13) and 14) apply, otherwise omit).

12) How far did you attempt to move through the smoke?

(a) No distance ☐ 1

(b) Three feet ☐ 2

(c) Six feet ☐ 3

(d) Twelve feet ☐ 4

(e) More ☐ 5

13) Were you

(a) Walking upright ☐ 1

(b) Running upright ☐ 2

(c) Crouching ☐ 3

(d) On hands and knees ☐ 4

14) How far could you see through the smoke?

- (a) No distance ☐ 1
- (b) Three feet ☐ 2
- (c) Six feet ☐ 3
- (d) Twelve feet ☐ 4
- (e) More ☐ 5

15) Where were you when the Fire Brigade arrived?

- (a) In original place ☐ 1
- (b) Attempting to leave the building? ☐ 2
- (c) Outside the building ☐ 3
- (d) Moving nearer to the scene of the fire ☐ 4
- (e) Moving away from the scene of the fire ☐ 5

16) How did you eventually leave the building during or immediately after the incident?

- (a) By your own efforts ☐ 1
- (b) By the efforts of the Fire Brigade ☐ 2
- (c) By the help of others ☐ 3
- (d) Not at all ☐ 4

17) Have you ever been involved in a fire incident before?

- (a) At home ☐ 1
- (b) At work ☐ 2
- (c) In another building ☐ 3
- (d) No ☐ 4

University of Technology,
Loughborough,
Leicestershire.

April, 1970.

The Behaviour of People in Fires

We are trying to find out if people react differently to fires in different kinds of building. This set of questionnaires is concerned with one particular incident and is composed of two parts.

Part I, which is about the fire and the building should be answered by the Fire Brigade Personnel. Part II comprises the six subsequent questionnaires, which are about people involved in the fire. The questionnaires in Part II are for use in interviewing six separate individuals who were in the building when the fire was discovered. We are interested in anyone who was in the building, not only the person who first discovered the fire.

We would therefore like you to interview as many people as possible who were involved with the incident. Both Part I and Part II should be handled by Fire Brigade Personnel, not by the person being interviewed. Where a question is followed by a list of suggested alternatives please tick the box opposite the most appropriate answer. Where a distance estimate is required please circle the relevant number.

Part 1 Information on the Building and Type of Fire

Address HARGREAVES
BELGROVE RD.
WELLING
KENT

Date 22-7-71

Time 0843

K433 Report Sheet Number 10071

1 Is a fire alarm (manual or automatic) provided in the building?
Yes ☑
No ☐

If so, was it used?
Yes ☑
No ☐

2 Is fire fighting equipment provided in the building?
Yes ☑
No ☐

If so, was it used?
Yes ☐
No ☑

3 If fire fighting equipment is not provided, was any other attempt made to extinguish the fire before the Fire Brigade arrived?
Yes ☐
No ☑

4 Are there any recognised escape routes in the building?
Yes ☑
No ☐

If so, were they used?
Yes ☑
No ☐

If "No", please specify why not

5 What category of building is it? *In general terms, for example – school, block of flats, shop, cinema, private dwelling house, multi-occupancy dwelling, etc.*

SHOP

6 What is the maximum number of storeys in the building? 3

7 On which floor did the fire start?
Basement = –1, ground = 0, first = 1, etc. 1

8 Approximately how many people do you think were in the building when the fire was discovered?
Please put the number in the box 12
Approximately how many left the building during the course of the fire? *If all, write ALL* ALL
How many people were rescued by Fire Brigade Personnel? 0
How many people were injured non-fatally? 0
How many people were injured fatally? 0
How many people were injured (fatally or non-fatally) in escaping the building? 0

9 How many
rooms were involved in the fire 2
levels were involved in the fire 1
constructions were involved in the fire 1

10 How many jets were utilised? 2

11 What was the extent of the smoke spread?
None ☐
Confined to room of origin ☐
Confined to floor of origin ☐
Spread to floor above ☐
Even more extensive ☑

12 What was the density of the smoke at its worst?
If, on the scale below, 7 represents the thickest smoke you have ever encountered, and 1 represents very thin smoke, put a cross in one of the spaces which represents the density of the smoke in this incident.

1 ☐ ☐ ☐ ☐ ☐ ☐ ☑ 7

rt 2 Information about the Person in the Fire

Male ☑ Female ☐ Age 46

How did you first become aware there was a fire?
- Felt heat ☐
- Saw flames ☐
- Saw or smelt smoke ☐
- Heard noises associated with the fire ☐
- Heard shouts ☐
- Was told ☑
- Heard fire alarm or fire engines ☐

Something else *please specify*

When you realised there was a fire, how serious did you think it was?
- Extremely serious ☐
- Quite serious ☑
- Not at all serious ☐

Which floor were you on when you realised there was a fire? ground ☐

Do you either live or [✓ work] in the building? Yes ☑ No ☐

How familiar are you with the layout of the building? Are you
- completely familiar with it ☑
- fairly familiar with it ☐
- slightly familiar with it ☐
- not familiar with it ☐

What was the first thing you did when you realised there was a fire?

Checked how serious fire was

What did you do next?

Instructed cashier to dial 999

and next?

then vacated building

How often have you received training on what actions to take in a fire?
- At least once per month ☑
- At least once every six months ☐
- At least once every year ☐
- Less frequently than once a year or never ☐

8 Did you know of any means of emergency escape in the building? Yes ☑ No ☐

9 Did you leave the building during the fire? Yes ☑ No ☐

If NO, please pass on to question 10

In leaving did you use
- The normal exits ☑
- An emergency exit ☐

Some other way *please specify*

Did you leave by
- Your own efforts ☑
- With Fire Brigade help ☐
- With the help of others ☐

Did you return into the building during the course of the fire? Yes ☐ No ☑

If you did, for what reason?

10 What reason did you have for not leaving? Was it because
- You did not think the fire was serious enough ☐
- You thought you would be safer where you were ☐

Some other reason *please specify*

11 Was there any smoke? Yes ☑ No ☐

If NO, omit the rest of this question

Did you try to move through it? Yes ☑ No ☐

If NO, omit the rest of this question

How far did you try to move through it?

Yards .... 0 .... 2 ... [✓ 4] .... 10 .... 12 .... 15 .... 20 .... 20+

How far ahead could you see at the time?

Yards .... 0 ... [✓ 2] ... 4 .... 10 .... 12 .... 15 .... 20 .... 20+

Did the smoke become thicker? Yes ☑ No ☐

Did you have to turn back because of it? Yes ☑ No ☐

If NO, omit the next part of the question

How far ahead could you see when you turned back?

Yards ... [✓ 0] ... 2 .... 4 .... 10 .... 12 .... 15 .... 20 .... 20+

12 Were any of the following people with you in the building during the fire?
- Your children under 12 ☐
- Your children over 12 ☐
- Your wife/husband ☐
- Your parents ☐
- Some other relative ☐
- Friends ☑
- Acquaintances ☑
- People unknown to you ☐

13 Have you ever been involved in a fire incident before? Yes ☐ No ☑

Part 2 Information about the Person in the Fire

Male ☐ Female ☑ Age 43

1 How did you first become aware there was a fire?
- Felt heat ☐
- Saw flames ☐
- Saw or smelt smoke ☐
- Heard noises associated with the fire ☐
- Heard shouts ☑
- Was told ☐
- Heard fire alarm or fire engines ☐
- Something else *please specify*

2 When you realised there was a fire, how serious did you think it was?
- Extremely serious ☐
- Quite serious ☐
- Not at all serious ☑

3 Which floor were you on when you realised there was a fire? ground ☐

4 Do you either live or [✓ work] in the building? Yes ☑ No ☐

5 How familiar are you with the layout of the building?
Are you
- completely familiar with it ☑
- fairly familiar with it ☐
- slightly familiar with it ☐
- not familiar with it ☐

6 What was the first thing you did when you realised there was a fire?

Went to rear where staff assemble

What did you do next?

Checked with other staff building was clear

and next?

waited outside with other staff

7 How often have you received training on what actions to take in a fire?
- At least once per month ☐
- At least once every six months ☑
- At least once every year ☐

8 Did you know of any means of emergency escape in the building? Yes ☑ No ☐

9 Did you leave the building during the fire? Yes ☑ No ☐

If NO, please pass on to question 10

In leaving did you use
- The normal exits ☑
- An emergency exit ☐
- Some other way *please specify*

Did you leave by
- Your own efforts ☑
- With Fire Brigade help ☐
- With the help of others ☐

Did you return into the building during the course of the fire? Yes ☑ No ☐

If you did, for what reason?

Check it was clear

10 What reason did you have for not leaving? Was it because
- You did not think the fire was serious enough ☐
- You thought you would be safer where you were ☐
- Some other reason *please specify*

11 Was there any smoke? Yes ☑ No ☐

If NO, omit the rest of this question

Did you try to move through it? Yes ☐ No ☑

If NO, omit the rest of this question

How far did you try to move through it?

Yards .... 0 .... 2 .... 4 .... 10 .... 12 .... 15 .... 20 .... 20+

How far ahead could you see at the time?

Yards .... 0 .... 2 .... 4 .... 10 .... 12 .... 15 .... 20 .... 20+

Did the smoke become thicker? Yes ☐ No ☐

Did you have to turn back because of it? Yes ☐ No ☐

If NO, omit the next part of the question

How far ahead could you see when you turned back?

Yards .... 0 .... 2 .... 4 .... 10 .... 12 .... 15 .... 20 .... 20+

12 Were any of the following people with you in the building during the fire?
- Your children under 12 ☐
- Your children over 12 ☐
- Your wife/husband ☐
- Your parents ☐
- Some other relative ☐
- Friends ☐
- Acquaintances ☑
- People unknown to you ☐

13 Have you ever been involved in a fire incident before?

Yes ☐

Part 2 Information about the Person in the Fire

Male ☐ Female ☑ Age 46

1 How did you first become aware there was a fire?
Felt heat ☐
Saw flames ☐
Saw or smelt smoke ☐
Heard noises associated with the fire ☐
Heard shouts ☐
Was told ☑
Heard fire alarm or fire engines ☐
Something else *please specify*

2 When you realised there was a fire, how serious did you think it was?
Extremely serious ☐
Quite serious ☑
Not at all serious ☐

3 Which floor were you on when you realised there was a fire? ground ☐

4 Do you either live or [✓ work] in the building? Yes ☑ No ☐

5 How familiar are you with the layout of the building?
Are you completely familiar with it ☑
fairly familiar with it ☐
slightly familiar with it ☐
not familiar with it ☐

6 What was the first thing you did when you realised there was a fire?
Gave help to person suffering from smoke

What did you do next?
Raised alarm

and next?
went into fresh air and phoned F.B.

7 How often have you received training on what actions to take in a fire?
At least once per month ☐
At least once every six months ☑
At least once every year ☐

8 Did you know of any means of emergency escape in the building? Yes ☑ No ☐

9 Did you leave the building during the fire? Yes ☑ No ☐
If NO, please pass on to question 10
In leaving did you use
The normal exits ☑
An emergency exit ☐
Some other way *please specify*

Did you leave by
Your own efforts ☑
With Fire Brigade help ☐
With the help of others ☐

Did you return into the building during the course of the fire? Yes ☐ No ☑

If you did, for what reason?

10 What reason did you have for not leaving? Was it because
You did not think the fire was serious enough ☐
You thought you would be safer where you were ☐
Some other reason *please specify*

11 Was there any smoke? Yes ☑ No ☐
If NO, omit the rest of this question
Did you try to move through it? Yes ☐ No ☑
If NO, omit the rest of this question
How far did you try to move through it?
Yards .... 0 .... 2 .... 4 .... 10 .... 12 .... 15 .... 20 .... 20+
How far ahead could you see at the time?
Yards .... 0 .... 2 .... 4 .... 10 .... 12 .... 15 .... 20 .... 20+
Did the smoke become thicker? Yes ☐ No ☐
Did you have to turn back because of it? Yes ☐ No ☐
If NO, omit the next part of the question
How far ahead could you see when you turned back?
Yards .... 0 .... 2 .... 4 .... 10 .... 12 .... 15 .... 20 .... 20+

12 Were any of the following people with you in the building during the fire?
Your children under 12 ☐
Your children over 12 ☐
Your wife/husband ☐
Your parents ☐
Some other relative ☐
Friends ☐
Acquaintances ☑
People unknown to you ☐

13 Have you ever been involved in a fire incident before? Yes ☐

APPENDIX 7

Revised Notes of guidance for the completion of questionnaire on "Behaviour of People in a Fire Situation".

General

The questionnaires are applicable to fires in buildings which are occupied at the time of the fire.

Each questionnaire consists of a booklet of seven pages. The first page is PART I of the questionnaire and the next six pages are identical PART II's. PART I is addressed to the Fire Brigade, and apart from the address, it is envisaged that it will be completed at some time subsequent to the fire.

The six PART II's are intended to be used in interviewing up to six people at the scene of the fire.

The number of PART II's has been settled at six as this seems a reasonable maximum number to aim for at any fire. However, if more than six people were seen, other booklets could be used.

Nationality of people interviewed - Although there is no space on the form for noting this information, it has been pointed out that this may well effect behaviour. Therefore if the person is not British, and where it would not cause offence, it would help if his nationality was written on the PART II concerned, in the space between the line, "Male", "Female", "Age", and Question 1, "How did you first become aware of the fire?".

Age limit of people interviewed - Again, although no specific minimum age limit is stated for persons being interviewed, it is considered that a sensible minimum would be 10 to 12 years old.

Number of People interviewed - There is no maximum number for the people interviewed. We would like as many people as possible in the light of the circumstances and time available. As far as possible we would like a cross-section of the people involved.

Accuracy of information obtained - It is recognised that some of the people interviewed, will for their own reasons either exaggerate, or tell outright lies about their actions. In many cases this will be obvious to the Fire Brigade Officer using the questionnaire. In such a case, if the Fire Brigade Officer has good reason to believe that the information given by any person is largely inaccurate, it would be useful if he could endorse the back of the particular intervie sheet with a comment to this effect.

So long as the completed questionnaires are legible, it does not matter if they are dirty or marked from being used at the scene of a fire.

Notes about specific questions

PART I

Time : This refers to the time of first call to the Brigade.

Question 2 : This means any recognised first-aid, fire-fighting equipment i.e. fire-buckets, hose-reels etc.

Question 7 : For example, for a bungalow "0" would be written in the box.

Question 8 : Where the number is small, less than 10, it is more important that the exact number is entered.
Where the number is between 20 and 60, an approximation to the nearest 10 people is acceptable.
Where more than 60 people were estimated to be in the building, an approximation to the nearest 50 is acceptable.
If in any case the answer is none, but a "0" in the box.
If the answer is not known at all, put a question mark in the box.

Question 12 : This question is to try and get some idea of how thick the Fire Brigade judge the smoke to have been at its worst. For example, if the smoke was about halfway between "very thin" and the thickest ever encountered by the member of the Brigade completing the questionnair the cross would go in the middle box.

PART II

Age : An approximation, i.e. 40 - 50, 35 - 45 is acceptable.

Question 1 : More than one alternative may be ticked if the person was simultaneous aware of a number of the effects of fire.

Question 6 : Brief statements are in order here. (for example, "Got dressed", "went to door", "ran down corridor", etc.)
More than one such statement may be put in each box.

Question 7 : This means training in its most general sense, to include any form of instruction concerning what to do in fire. i.e. visits or lectures by firemen etc.

Question 9 : If the answer is "yes" to this, ignore Question 10.

Question 12 : More than one alternative may be ticked.

APPENDIX 8

Reclassification of Actions

Actions were recategorised so as to include under each heading those responses which expressed similar intent. Where actions were undertaken by only a small percentage of the respondents, a "miscellaneous" category was allocated which we have chosen to call "Something else". The full list of reclassifications is shown below.

	New Action	Original Actions
1.	Investigate	Investigate fire More towards fire
2.	Contact Fire Brigade	Contact Fire Brigade Enquire if Fire Brigade sent for
3.	Alert others	Warn other people Raise general alarm Contact someone in authority
4.	Evacuate self	Move towards exit Leave building
5.	Evacuate others	Organise evacuation Get family out of building
6.	Fire-fighting	Some fire-fighting action Assist Fire Brigade
7.	Minimise risk	Something to minimise risk Switch-off gas/electric Shut doors
8.	Increase risk	Something which increases risk Move burning object
9.	Request assistance	Request help from others Await rescue by Fire Brigade
10.	Render assistance	Give help to others Attempt to rescue someone
11.	Retreat from fire	Move away from fire Move to safe place
12.	Something else	Save personal effects Return into building Get dressed Cover face with wet towel

Where individuals undertook a course of action which ended in them "doing nothing", which we have previously categorised as "Inaction", we have ignored the Inaction category and merely categorised the "actions".

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