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THE ROLE OF THE FIRST LINE SUPERVISOR IN CONSTRUCTION SAFETY: THE POTENTIAL FOR TRAINING

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Submitted for the Degree of Doctor of Philosophy

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SUMMARY

The research explored two broad questions:

1) the scope for influence of the first-line supervisor on safety in construction sites
2) the training needs of supervisors to exercise that influence

The characteristics of the construction industry and construction process which influence safety and the role of the supervisor were described. A problem-centred diagnostic method was developed to explore the role through the individual perceptions of supervisors.

The research method consisted of three major steps:

1) the development of a list of "accident symptoms" from an analysis of a large sample of accident reports;
2) the detection of symptoms during on-site inspection, using the list as a guide, and their use as stimuli in a focussed interview to discover the factors influencing the supervisors' perception and evaluation of safety;
3) the checking of the extent to which supervisors' expectations are concurrent with those of other role incumbents.

The method proved acceptable to supervisors and fruitful in generating relevant data. The range of variation within the industry prohibited the development of general descriptions of role and training needs, but a revised version of the research method is recommended for use in eliciting specific needs for individual supervisor/site units.

The interview data were categorised and analysed to reveal 15 factors affecting the different stages of perception and evaluation. Their prevalence and influence on the supervisors' role conception, role problems and the ways of coping with the problems are discussed.

Safety training needs were found to be inextricably bound up with the total management of the construction site. Hence the optimum balance of change programmes to improve site safety, must depend upon analysis of individual supervisor/site units in the light of their management policy.

Further development of the research to allow more quantitative analysis is suggested.

CONSTRUCTION

SAFETY

SUPERVISOR

TRAINING

To My Parents

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CHAPTER 1

GENERAL INTRODUCTION

1.1 Origin of the Research Project

This research project forms a part of the research programme undertaken by the Department of Safety and Hygiene, of the University of Aston in Birmingham, in the field of safety in industry.

The available statistics indicate that the accident record of the construction industry is far worse than that of the manufacturing industry. Table 1 shows the incidence rates per 100,000 at risk of fatal and total accidents, reported[1] to Her Majesty's Factory Inspectorate (HMFI) for the years 1971-75 (Great Britain: Health and Safety Executive 1977).

In view of the difference in the levels of under-reporting between the two industries, the rates of non-fatal accidents were considered incomparable. The extent of this difference was highlighted by a survey in 1969/70 involving a comparison with industrial injury benefits (ibid) which estimated the proportion of non-reported accidents in the manufacturing and construction industries to be about 27% and 50% respectively. The corresponding proportions in 1962 (Great Britain: Ministry of Labour 1963) were about 38% and 50%. In view of the greater depression of the rates for construction than for manufacturing, although both industries have similar total accident rates in Table 1, the rate for construction should be higher than for manufacturing.

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1 An accident is notifiable if:

(a) it causes loss of life to a person employed in premises subject to the Factories Act; or

(b) it disables any such person for more than three days from earning full wages at the work at which he was employed

TABLE 1

	1971	1972	1973	1974	1975
MANUFACTURING INDUSTRY					
Incidence rate of fatal accidents	4.3	3.9	4.2	4.5	3.7
Incidence rate of events leading to fatal accidents	4.2	3.8	4.0	4.0	3.5
Incidence rate of all reported accidents	3,540	3,250	3,710	3,520	3,490
CONSTRUCTION INDUSTRY					
Incidence rate of fatal accidents	19.6	18.7	21.6	16.0	18.1
Incidence rate of events leading to fatal accidents	18.9	17.5	21.0	15.9	17.2
Incidence rate of all reported accidents	3,570	3,650	3,540	3,330	3,530

Incidence rates per 100,000 at risk of accidents in the manufacturing and construction industries 1971 - 1975

However, incidence rates pertaining to fatal accidents, due to the fact that they are always reported, are a better criterion for comparison. On this basis, the accident problem of the construction industry is far worse than that of the manufacturing industry.

For this reason the construction industry seemed a natural choice for a research study, coupled with the fact that the researcher's own background is as a civil engineer with experience in the construction industry.

In the construction industry the supervisor frequently comes from the working group and shares a good deal with it in respect of common traditions, attitudes and feelings. He receives orders and information from his superiors, co-ordinates the operations and activities of different work groups and interprets and reflects the views, attitudes and complaints of the work force to management (a detailed discussion of the construction supervisor appears in Chapter 3). Therefore, the supervisor occupies a vital position in construction site organisations.

It has been claimed that supervision is of crucial importance to safety. The report of the Robens committee (Great Britain: Department of Employment 1972) stated: "It is the supervisor who is on the spot and in a position to know whether or not safety arrangements are working in practice. His influence can be decisive. Both here and abroad, wherever we have seen outstanding safety and health arrangements, it has been clear that a key role is played by well trained supervisors who are held accountable for what happens within their sphere of control. We are not at all satisfied that this key role in safety is sufficiently recognised throughout industry generally, or that enough is done to equip supervisors for it".

Supervision was therefore considered a fruitful area for a study on safety in the construction industry.

This research project was undertaken primarily to study the role of the supervisor in safety on construction sites. The important questions that the research set out to answer were,

I. What is the scope for supervisory influence to improve safety on construction sites?

II. What are the barriers to supervisory influence, and particularly what is the scope for training?

1.2 Area Covered In This Study

A complete answer to the broad questions cited above, is beyond the scope of one thesis. Therefore, the area of the research was narrowed down to a manageable size within the confines of the construction industry in the UK.

1.2.1 Types of Construction

The construction industry incorporates a wide range of diverse activities (these are discussed in Chapter 2). They can be categorised broadly into the following types:

1 New dwelling construction
2 New public and commercial building construction
3 New industrial construction
4 New works of civil engineering construction
5 Work on existing structures, (eg. repairs, maintenance, conversions, improvements, etc.) of the above types.

In order to ensure applicability to the whole of the industry in this study, data were collected from sites belonging to all these categories.

1.2.2 Safety in Construction

There are three different sorts of safety in construction.

(a) Intrinsic safety of the structure, either during or after construction. This depends on the sufficiency and suitability of the design and the arrangements of the permanent structure to meet the demands brought upon it, particularly as regards the interaction of load and structure.

(b) Safety of the environment, public, and the users as a result of the nature of the built structure. This concerns the adequacy and the suitability of the structure for the purpose for which it was constructed and the position in which it was sited.

(c) Safety of the process of construction. This concerns the series of activities undertaken between the initiating point, and the point of completion and handing over the structure, as regards danger to personnel and/or property, both inside and outside the construction site.

(a) and (b) above are concerned with the products of construction, where as (c) is concerned with the production process. This research will consider only(c).

1.2.3 Supervision in Construction

In the construction industry, the term supervision is used in two different contexts.

(a) Supervision of the contractors work by the client or the consultants, to ensure that the constructed works complies with the design details and the specifications as set out in the contract agreements.

(b) Supervision by line management of the progress of the site work, as in manufacturing industry, for the purpose of controlling, directing, etc.
This research will consider only (b).

1.3 Scope of the Project

It is a common belief that safety is an integral part of any human endeavour. An attempt to look specifically at the safety role may be seen as undermining this fact. However, this is not so. In order to gain an insight into the safety aspects of construction supervision, it is necessary to bring them into sharp focus. There is a variety of factors other than supervision, which affects safety on sites. Also supervision is concerned with a multitude of other aspects of site organisation besides safety. In order to identify the critical elements of the supervisory job influencing safety in the work place, attention has to be paid to safety aspects against the background of the remainder of the job. Therefore this study is not an attempt to treat safety in isolation, but rather to study it ingreater detailwithin the framework of the whole organisation.
Organisational patterns and systems in different industries have been developed and evolved over the years according to the technology employed and the existing value demands. Construction, being one of the earliest industries in human history, exhibits well established industrial practices, which have evolved to meet the specific economic, technical, social and psychological demands of this industry (These are discussed in detail in Chapter 2). Safety of people at work

as a performance criterion needing separate attention began to assume importance in this industry only a few decades ago (This is discussed in Chapter 4). It is bound to require changes in the way the industry functions. Research studies on the way the role definitions and role relationships within organisations in this industry are affected as a result of the insistence on adequate safety performance, are more important to bring about the changes more effectively and smoothly. The crucial questions are, in what ways are the roles and relationships affected and how are the individuals involved, likely to respond?

The notion of "role expectations" is useful in explaining how human behaviour in organisations is influenced and controlled. The safety role of the supervisor is seen here as the part

played by the supervisor in maintaining a satisfactory level of safety on sites.

Studies of the relationship between supervision and the level of safety on construction sites are few. In view of the scarcity of accurate information and detailed knowledge from past work it was not possible to formulate and test detailed hypotheses, for which a clear understanding of all the applicable variables would have been essential. The approach adopted was therefore one of investigation of the problem area to identify and describe its significant characteristics. The main value of this study is in its exploration of a new area to identify and describe the characteristics crucial to the problem. The aim was to allow hypotheses to be generated at the end of the study.

In field research, a major distinction can be made between purely academic research where the researcher need not be concerned with the practical value of his findings and research studies which aim to produce findings which are of practical value, in addition to being theoretically significant. In view of the extremely complex nature of the construction industry (discussed in detail in Chapter 2) and the scarcity of detailed knowledge in the area, the findings of heavily controlled research are likely to be of little practical value. In addition there would be enormous practical difficulties in setting up controlled research experiments. Therefore, it was decided, in the context of the present research, that maximum practical value would be achieved by a descriptive study. Since of necessity such a study must involve a flexible technique, this was the approach adopted in the present research.

1.4 Background Information

As mentioned before, construction site supervision and construction site safety are both vastly complex areas. In order to develop a technique appropriate for the investigation of the relationship between them, it was vital to obtain a detailed and intimate understanding of the overall set up of the industry. The background experience of the researcher in the construction industry as a chartered civil engineer and a Construction Factory Inspector was immensely useful in this context. At the beginning of this research, the researcher spent much time in a total of twelve construction sites of different types, making observations and having discussions with the senior management, supervisors and operatives, in order to gain further familiarity and understanding of the problem area, Much information was also available in the literature in connection with the following separate fields.

I The nature of construction projects and the way they function.

II Supervision and supervisory training in industry in general, and in the construction industry in particular.

III Safety on construction sites.

This is an oversimplified demarcation of areas and they are of course closely intertwined. Chapters 2, 3 and 4 of this thesis assemble the knowledge gained by experience, initial site visits, and the literature in the above mentioned three areas, as they influence the techniques and findings of this study. A suitable framework and methodology for the study was developed on the basis of this knowledge and relevant studies in associated fields.

The techniques used in this research were therefore 'tailor made' to investigate the problem under study.

1.5 Objectives of the Research

Construction supervisory jobs and the work environment in which they were carried out were found to change continuously. Therefore devising methods of describing and evaluating each case, on a one-off basis was considered far more important and useful than drawing up a prescriptive manual of role behaviour or training needs as regards safety.

Child (1970) pointed out that in the present state of knowledge, managers have to work through their organisational problems by assessing individual cases, virtually from scratch, and that they should be able to secure valuable advice from social scientists. An important aim of the research was therefore to provide an indication of the information necessary, in order to evaluate the most appropriate safety role and the safety training needs of the supervisor in a particular situation.

The main objectives of this research were therefore defined as follows.

1) To develop and test a methodology appropriate for studying and analysing specific cases and hence provide a tool suitable for investigating the role of the supervisor in safety on construction sites, and particularly the supervisor's training needs.

2) To describe the role that the supervisor plays in safety on construction sites and to identify and provide an understanding of the areas in which an improvement would be necessary and/or beneficial.

3) To obtain an understanding of the factors which influence the role of the supervisor as regards safety, and to highlight the characteristics of the industry and its organisation which affect this role.

It was also expected that the techniques thus developed and the body of knowledge thus assembled would be useful in the investigation of different construction situations for the development of action programmes in general and training programmes for supervisors in particular. They would also provide direction, guidance and information useful for the long term development of supervision to meet the safety demands of the construction industry. The research method adopted to achieve the above objectives was based on an investigation of the perceptions of the supervisory role, rather than on a comparative study of safety.

1.6 The Layout of the Thesis

Chapter 1 is a general introduction to the thesis. It includes a definition of the area and problems under investigation, the scope of the study, a statement of its objectives and the present section.

Chapter 2 describes the nature and practice of the construction industry relevant to this research. Primarily, it provides an understanding of the work situation in which the construction supervisor carries out his job, and the principal characteristics of the industry that are of importance to safety.

Chapter 3 is a description of the job of the construction supervisor in relation to the objectives of this study. The implications towards the techniques appropriate for an investigation are also discussed.

The concepts and issues concerning safety are discussed in relation to this study, in Chapter 4. A diagnostic approach to the study of safety on construction sites is suggested.

The methodology used in this research is described in Chapter 5. It includes a field investigation consisting of three parts.

A description of the first part of the field investigation and its results are presented in Chapter 6. A table of accident symptom occurrences on construction sites is the final outcome of that investigation.

Chapter 7 describes the second part of the field investigation, which consisted of the supervisory interviews on sites. The results of that investigation are also included in this chapter.

An analysis and discussion of the results of part 2 of the study are presented in Chapter 8.

The third part of the investigation in which the supervisors as well as their respective superiors and safety officers were interviewed on a limited number of sites is presented in Chapter 9, together with a discussion of its results.

Chapter 10 consists of a general discussion of the implications of this research for its stated objectives, the conclusions of the study and indications for further research.

CHAPTER 2

THE CONSTRUCTION INDUSTRY

2.1 Introduction

This chapter describes various aspects of the Construction Industry that are of particular importance to the research. It forms the basis of the next two chapters concerning construction supervision and construction safety. An appreciation of the characteristics and practices of the industry which have an influence upon both safety and supervision on the sites was considered to be vital for a more complete understanding of the safety role of the supervisor, as well as for developing an appropriate methodology for this research. This chapter also defines the broad boundaries of the research area.

2.2 Construction Activities

Traditionally, the construction industry is divided into two sectors: civil engineering, and building. Civil engineering work includes structures that are not primarily architectural in nature, but involve predominantly engineering field materials such as, earth, rock, concrete, steel etc. Work on highways, dams, tunnels, reclamation projects, pipelines etc. are just a few examples of the enormous range of activites included in this category. Building operations are concerned with building for residential, institutional, social, commercial, industrial etc. purposes. They are broadly separated into three categories: dwelling construction, public and commercial building construction, and industrial construction. However, the distinction between the two sectors is not clear-cut. For example, in large industrial construction projects (such as petroleum refineries, power generating stations etc.), work on the heavy foundations, wharf and railway and roads are clearly civil engineering, whereas the cladding to the above ground structure and the internal finishing are as clearly building.

Construction does not consist only of new construction work. It includes a wide variety of other types of work such as repairs, maintenance, renovations, extensions, demolition, alterations and other operations on existing structures.

It is therefore clear that there is a whole spectrum of different types of construction work from major civil engineering projects to minor building activities.

The very individualistic nature of every site and the enormous number of possible variations in one aspect or the other and the transitional nature of the work on any particular site, make it impossible to divide them into any meaningful categories in order to differentiate between them. The approach adopted in the study was therefore to direct the findings towards the nature of the problems rather than the specific problems themselves so as to be able to generalise the findings to the whole range of activities. The number of sites that could be used in this research was limited by the resources and the time available. In order to ensure that the sample selected was reasonably spread across the spectrum, the activities were broadly categorised into the following types.

I New dwelling construction

II New public and commercial building construction

III New industrial construction

IV New works of civil engineering construction v Work on existing structures (repairs, maintenance, conversions, improvements etc.) of the above types.

2.3 Formal Procedure in Construction

Construction is in many ways, a special industry, with special features which differentiate it from the majority of other industries. In view of the need to fit the structures to their physical environment and to satisfy a client's particular requirements, each product of the industry is unique in many ways. Temporary duration of work at any one site and exposure to varying weather conditions are inherent features in construction. Work-loads fluctuate with demand, and firms in this industry have less control over their work and environment. These factors have led to the evolution of a set of procedures and practices which provides adaptability to enable the organisations to cope with the industry's varying demands. These procedures have a marked influence upon supervision as well as safety on sites. The following is a discussion of the formal procedures adopted in construction[1].

The three most important phases of the construction process are 'Project Conception', 'Project Design', and 'Project Construction'.

Project conception is the recognition by a prospective owner (client), of a need which can be satisfied by a physical structure.

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1 This discussion draws heavily from a number of publications. A few examples are the ICE conditions of contract (Institution of Civil Engineers 1973), the Banwell Committee Report (Great Britain: Ministry of Public Building and Works 1964), NEDO reports (eg. Great Britain: The National Economic Development Office 1974, 1976) and Twort (1972). ICE Civil Engineering Procedure.

The project design phase translates the primary concept into an expression of a spacial form which will satisfy the owner's requirement. It involves an Engineer, Architect and/or Designer.

Project construction is the final phase that creates the physical form which satisfies the conception and permits the realisation of the design. It is carried out by a professional constructor, known as the Contractor or Builder. In certain projects, construction is carried out by direct labour employed by the owner.

In addition to the above three parties an individual who is trusted by each of them co-ordinates their respective functions and ensure satisfactory administration of the whole process. He is known by the titles Resident Engineer or Clerk of Works.

It is the project construction phase that is more relevant to this study. The area of management particularly responsible for this phase is the 'Site Management'. It covers the part of the construction management in respect of the work undertaken by the main contractor or directly by the client as the case may be and carried out directly on site. It concerns the general control of all activities on site. In one context, it refers to the field of site management activity; in the other, to the line management personnel engaged therein.

2.3.1 The Client

The usual way a construction project is undertaken in practice is for it to be commissioned by a client (or owner), who defines the functional needs of the structure, obtains the necessary permissions and provides the finances for the project. This is the first phase mentioned above. The requirements of the client therefore, dominate most projects. The primary objective of every client is to get a structure that satisfies the perceived needs within the limits of price and time. The systems, procedures and methods adopted by organisations in the industry are basically designed to meet these demands. Their influence upon safety and supervisory functions will be discussed later. A client can be either an individual, or any one of many forms of organisations such as a local government authority, a government department, a company, a corporation or a joint board. Often the progress of construction is subject to the influence of decisions and decision changes on the part of the client. These can involve many complexities when the client organisation is large or complex.

2.3.2 <u>The Contract</u>

Two types of engineering specialist services are required for the satisfactory execution of a construction project; one to undertake the design and the other to undertake the construction.

Some client organisations are able to undertake one or both of these functions themselves. In some cases, both functions are handled by one outside organisation (package-deal contract). In a large majority of the cases, they are carried out by two different outside organisations in which case the design organisation is commonly known as consultants, and the construction organisation as contractors.

The distinctive nature of every project requires a contractual agreement between the contractor and the client specifying the work to be done, the quantities, the quality of every element and many other conditions. There is a variety of ways in which a contract for construction may be drawn. The supervisor's position and responsibilities, as well as the nature of pressures upon performance can be influenced by the type of contract.

Each site studied in this research belonged to one of the following common forms of contract.

i. <u>Bills-of-quantities contracts</u>

The bill-of-quantities indicates the amount of work to be done under each item as measured from the contract drawings, and their prices. The total sum of the contract is the sum of the individual items as priced in the bill including any prime costs, lump sums, and provisional sums. When the work is constructed the quantities are replaced by the measurement of the actual quantity of work carried out.

ii. <u>Schedule-of-rates contracts</u>

In the schedule of rates the quantities of the individual items are either not inserted or they are entered in estimated amounts of provisional quantities. Payment is made on the basis of the measured quantity of work carried out. Therefore, these contracts are very similar to bill-of-quantities contracts.

iii. <u>Lump-sum contracts</u>

This type of contract consists of a single lump sum tendered and accepted as a fixed price. It is sometimes used in conjunction with a schedule of rates, in order to be able to price any variations.

iv. Reimbursable costs contracts

These require that the contractor is paid his actual costs, plus a sum over and above that cost to allow for his overheads and profit. The additional sum is stipulated either as a percentage of cost (cost - plus percentage contracts) or as a fixed amount (cost - plus fixed-fee contract).

The client selects the type of contract that he finds most appropriate to the circumstances. In some cases, a bonus or penalty is included relating to completion of the whole or part of the work within a set time target.

Contracts are also subject to many risks and unforeseeable conditions. Certain risks, such as delays due to bad weather, are accepted as normal, for which it is usual to make an average allowance in the sums quoted. There are other unaccountable risks and unforeseeable conditions (eg. the geological conditions far worse than expected at the time of inception of the contract) for which the cost is often payable by the client. A contractor cannot be deemed to have contracted to do things which, at the time of the contract, were beyond the possibility of his conceiving as a competent contractor. However, if losses occur due to the contractor's inefficiency or the normal risks exceeding the allowance (eg. bad weather costing more than the allowed proportion) then the contractor has to bear the costs. When these losses are substantial, unless covered by extra profits from other jobs, the only alternative is for the contractor to go bankrupt. Twort (1972) stated: "The root difficulty with regard to imposing excessive or indefinable risks upon a contractor is that there cannot be a valid contract between two parties to do something which cannot be defined. There are three essential parts to a valid contract: the intentions in the minds of the employer as expressed in the contract documents; the interpretation in the mind of the contractor as evidenced by his tender; and the object of their mutual agreement."

It is evident that the field of construction contracts, being fiercely competitive, demands a very high degree of efficiency from contractors. Different forms of contracts may impose different sorts of pressures upon the site personnel. In the case of certain types of unexpected events, mere survival of the firm can require drastic measures.

2.3.3 The Consultants

In the traditional organisation of the construction process where the contractor is usually selected by competitive tender, the client depends on the professional services of the consultants for some or all of the following functions.

i. Preliminary investigations and other research work.

ii. Design of the work to suit the needs of the client.

iii. Preparation of the contract documents which include the following.

(a) The 'contract drawings' which pictorially show the works to be built, their dimensions, levels etc.

(b) The 'specifications', which describe in words the works to be built, the quality of materials and workmanship to be used and methods of testing etc.

(c) The 'bill of quantities' which sets out the expected measure of each operation of construction as calculated from the drawing, classified according to trade or location within the proposed work.

(d) The 'general conditions of contract' which define the liabilities, responsibilities, and powers of the mployer, contractor and engineer, and covers such matters as methods of payment, insurance, liability of parties to the contract etc.

(e) The 'tender' which is the signed financial offer of the contractor to construct the works in accordance with (a), (b), (c), and (d) above.

(f) Any 'letters of explanation' which are agreed between the parties to the contract as elucidating or amplifying their intentions with regard to the foregoing matters.

(g) The 'legal agreement' which is signed by both parties, confirming their respective intention to have a contract between them as defined by all the foregoing documents.

iv. Selection of contractor/s by public advertisement for tenders or from a list of selected tenderers.

The consultants, after examining the tenders, usually carry out a further examination of the capabilities, proposed method of construction, projected programme, etc. of a small number of the lowest bidders, before advising the client as to the most suitable contractor. However, unless the contractor who made the lowest priced offer was found unacceptable or another contractor was found far more suitable, the lowest bid is the main criterion of selecting the contractor. Once the contractor is selected, the agreement of the contract is between the client and the contractor.

v. Administration of the contract for construction to ensure that the construction is carried out in compliance with the design expectations and the schedule of work. This includes the measurement and testing of works and approval for payment. The function of administration is carried out through the resident engineer or the clerk of works.

vi. Advising the client in all aspects of the project.

The main engineering professions, contributing to a consultants organisation are those of the structural engineer, architect and quantity surveyor. It is important to remember that the consultant can be an independent organisation or a part of the client organisation. It is clear from the above that the consultants largely dictate and control the activities of the contractor's organisations in construction projects and thereby influence safety and supervision on the sites.

There are also many alternative approaches to organisational arrangements in the construction process. These represent deviations from the traditional organisation with respect to the role of the consultant, that of the contractor, and/or the ways of appointing the contractor. The following are some common examples:

- i Negotiated Contracts
- ii Package Deal Contracts
- iii Contract Management
- iv Two-stage Tender
- v Serial Tender
- vi Continuity Tender

2.3.4 The Construction Phase

The main responsibility for the actual carrying-out of works, once the plans, specifications and other contract documents have been finalised, lies squarely upon the contractor.

The contractor's organisation needs to gain familiarity with the technological details and the operational realities. It has to acquire the managerial and organisational skills required along with the equipment and other material resources necessary to 'get the job done'. The nature of the contractor's services in meeting the client's need for the speedy, efficient and economic translation of the functional idea into concrete reality, makes the site organisations highly vulnerable to a variety of influences from outside the site. (These influences are discussed in Section 2.5)

As regards the organisational functions of a contracting firm, distinction is called for between the company level, at which the organisational structure is similar to that in any other business enterprise, and the site level, at which it must be tailored to the nature of the project.

2.4 Studies on the Construction Process

A recurring theme in all the reports of inquiries and studies on the construction industry is the need for closer integration of the design and production functions. The Simon Committee Report, (Great Britain: Ministry of Works 1944) and the Banwell Committee (Great Britain: Ministry of Public Building and Works 1964) all commented on the lack of cohesion between these functions. Methods which permit the earlier selection of the contractor were recommended to be adopted, so that he was able to make a contribution in the development of every stage of a project from its inception.

A preliminary exploration of the building process was made by operational research workers and sociologists in a Building Industry Commissions Research Project (Tavistock Institute 1966). This approach, being from a new perspective, threw some new light on some aspects of the construction process. They found a high degree of interdependence between the various functions that form the sum total of the construction process, yet these functions are being carried out independently. The building industry was found to operate through an information system which was inadequate to meet the necessary demands. An informal system, far removed from the formal structure of the roles and responsibilities was found to exist. As a direct result of the inadequacies and weaknesses of the formal system to meet the demands of the industry the methods and procedures actually adopted by persons in their repective roles were found to follow this informal system. This was found to impose a variety of stresses and conflicts upon the personnel concerned. Also the individual participtants in the building process were found to have to make decisions in the face of numerous uncertainties, as regards the performance of the others, and unforeseen influences from outside agents.

Although the contract was entered into according to a standard set of contract documents, it was found very unusual for every party to be fully certain of the detailed implications of the contract (ibid). In many projects, the question of the cost and the detailed criteria of functional needs were neither clear, nor resolved completely either prior to design, or in many cases even until the construction had progressed quite far. Higgin and Jessop (1965) identified the following problems of communications in the building industry.

I. "Building is a service industry, it makes specific things to customer's order. But many prospective customers do not know enough of the range of technical and professional services available to them to decide their orders satisfactorily, or to make the first approach to the industry which is appropriate to their needs."

II. "There is seldom a complete enough exploration of all the client's needs and of the limitations he must accept-nor is he sufficiently informed of all the possible means of meeting his needs. The matching of needs and possibilities is seldom fully achieved, so the brief can rarely be adequate and clearly understood by all. This can lead to difficulties and reduced efficiency at all subsequent stages of the project."

III. "Sufficient thought and time does not seem to be given to ensuring, either as a design team brief or during the designing process, that all who must contribute understand the common objective similarly and fully. There is seldom a full awareness of all the steps necessary to realise an optimum overall outcome without loss of time, and the means of ensuring design co-ordination is often not clear."

IV. "---when a contract is entered into it is unusual for any of those concerned to know with any degree of certainty just what he can expect of others, and what others will expect of him. The nature of relationships is defined afresh for everybody as any project develops, at the price of delays and confusions. The frank sorting out of these difficulties at the commencement of a contract is prevented by the silent reservations of all parties about points of possible disadvantage each feels he must watch for."

V. "The basic decisions of construction control are often incompletely or unduly rushed because necessary information is not available sufficiently ahead of time, or is not complete enough. On many occasions members of the construction team could, but do not, ease this problem by supplying the data that would facilitate the preparation of fuller and more useful information by others. Building construction is remarkable among industrial activities for the lack of detailed information about how it proceeds."

As a result of these communication problems it is a common practice in this industry for clients and consultants to order various alterations at different stages of construction while the project is in progress. These belated alterations produce much confusion and cause major disturbances for those engaged in the principal task of construction.

Exclusion of contractors, who will eventually undertake the construction, from the process of design in most construction projects, accounts for the absence of much valuable information in crucial design decisions. Since the details pertaining to the resources or the technical know-how of the contractor are lacking at the design stages, they are usually assumed or taken for granted. Subsequently however, any errors in these assumptions can cause serious problems to the construction personnel, during construction.

In the contract for construction, the contractor often has to fix a price for his work as well as a date of completion. The information available at this stage can usually hardly justify such commitment. The procedure does not allow for the many unforeseen circumstances that are common in construction work. By the nature of the competition involved in gaining a contract (the very existence of a construction firm can depend upon winning a particular contract), the successful contractor may have quoted a lower price and agreed to complete the job in a shorter time than better judgement would warrant. Most contractors who find the cost exceeding their estimate and/or the job taking a longer time than was intended find the need to invent ways of obtaining more money and/or providing excuses for delays. Consultants who are well aware of this situation find it necessary to adopt measures to counteract such manoeuvres as a part of their duty to safeguard the interests of the client. Thereby, the procedure gives rise to conflict in the relationship between the parties to the construction process.

The study by the Tavistock Institute (op cit) found that the realities of construction do not justify the expectations that the client, consultant and contractor had at the time of finalising the contract and made implicit in the contract documents. It was observed that an informal system was adopted by the resource controllers, through necessity, because the formal system based on characteristics which are inconsistant with reality, could not meet the demands adequately. A process of adaption, accompanied by much uncertainty, friction and stress was found to take place within the progress of the project, to suit the specific circumstances.

Very few contractors enjoy continuity of projects, and so find it difficult to maintain permanent resources in terms of personnel and equipment in their firms.

Until a contractor is accepted for a project, and the contract is signed he is not certain of that job, and therefore, may have to acquire the personnel and resources necessary for that project in a very short time. This invariably gives rise to weaknesses in the organisation.

Most contractors submit tenders for more jobs than they are able to undertaken at one time in order to allow for the very high probability of not being successful in many of them. In the event of a contractor winning more of those contracts than expected, the problems of building up the personnel and resources and managing the projects can escalate to such proportions as to cause the resultant organisation to be unable to meet the demands.

Demands placed upon the structure of the industry are inconsistent with the way it is organised. There is insufficient continuity of work for a large number of contractors, mainly because there are too may contractors chasing a limited number of jobs. The Lofthouse Report (Economic Development Committee for Civil Engineering 1966) showed that there were about 90 firms on the Ministry of Transport's list of contractors capable of undertaking road contracts to the value of £250,000 and over. In the three years from 1962 to 1964, the number of such contracts placed by the Ministry was just over 90. These were placed with about 50 contractors, very few of whom enjoyed any continuity in road building work. Most contractors are therefore not able to maintain a steady load of work for themselves. Their employees, including the site management, lack continuity of employment with a particular contractor.

The characteristics discussed above do not apply uniformly over the whole spectrum. There is a large number of construction works where the organisational arrangements are different. For example, it was mentioned that in certain construction works, the client does not have to employ a contractor. A large number of construction works are carried out by direct labour (particularly repair and maintenance), by clients who employ sufficient staff and workmen and have sufficient equipment and facilities (eg. local authorities). Also, the characteristics pertaining to the alternative approaches to organisational arrangements mentioned in section 2.3.2 are likely to be different from those pertaining to the traditional arrangements. These differences have to be borne in mind in dealing with any particular construction situation.

2.5 Other Influences

Apart from the client and consultants, there are many other bodies and agents, such as planning authorities, material suppliers, a number of different enforcing authorities and parties affected by the particular construction, who exercise much influence upon the activities during the construction stage. Changes are often made necessary by one or more of

these parties during the process of construction. Bishop (1967) and Docherty (1971) amongst others, have pointed out that the building industry is subject to an unusually high degree of intervention and control by outside organisations.
Many clients find the need to occupy the new structures that are built at the earliest possible time, for economic and other reasons. This sometimes makes it necessary for the premises to be occupied before completion of the site activities. Often, additions, extensions, alterations, improvements, repairs, maintenance etc. of existing premises are undertaken while they are still occupied. The presence and free movement of personnel unaccustomed to construction operations within the site boundaries can cause serious problems to the site management and operations. Also, other activities in occupied areas can cause problems to the activities and personnel of the construction team. Invariably special precautions are necessary for the safety and security of the occupier's property and personnel from undesirable construction influences. Sometimes the construction property and personnel have to be protected from the undesirable influences of the occupier's activities.
Many construction projects are undertaken near or adjacent to public areas, such as roads, various public buildings, parks, playgrounds etc. The protection of neighbouring personnel and property, passers-by and children or adults who may be attracted onto the site through curiosity or other reasons, imposes additional responsibilities of an uncertain nature upon the site management.
There are many uncertainities which continuously cause serious interference with the smooth functioning of the

construction process. Inadequate advance knowledge of geological conditions or of the behaviour of the weather are just two examples.

2.6 Types of Contractor

There are two categories of contractors working in the industry: general contractors and specialist contractors. The type of work carried out by each complements that of the other. The general contractors are those who prefer to compete for a variety of different types of jobs. The bidding for a particular job by a general contractor usually depends on whether he is able to finance and manage the project, rather than on technical considerations. The recruitment of site management with sufficient competency is crucial in such cases. The possibility of the construction team not being familiar with solutions to some of the problems found in unfamiliar types of construction is very high. The other category, the specialist contractors, specialise in a particular type of construction activity. They usually have expertise in their specialised field and limit their main contracts to projects involving such work. In addition, they commonly provide specialist services to the general contractors.

2.7 Sub-Contracting

The system of sub-contracting in this industry has developed because of the inability of most contractors to keep the different teams of specialists who are required to carry out any particular project, permanently occupied. The terms main contractor and sub-contractor are not synonymous with the general contractor and specialist contractor. The main contractor or a sub-contractor in a project can be a general contractor or a specialist. A sub-contract may be granted by the client, or by the main contractor. When granted by the client, it is known as a nominated sub-contract, and the contract is independent of the main contractor. In the other case, the contract is between the main contractor and the sub-contractor concerned. Then the main contractor is responsible to the client for the work of the sub-contractor. The main contractor's site organisation has a much lesser say in the work of the nominated sub-contractor than that of the other. The work of the main contractor and different sub-contractors are usually interconnected with one another in many ways. The most common is the work of one having to be followed by that of another in a series of sequential operations. Those sub-contractors who work on more than one project at a time because of the intermittent nature of the demand for their work on any one site, cause serious problems in co-ordinating the work. A gang may turn-up sooner or later than they agreed to, or if they turn-up on time, the previous gang may not have completed their part of the job, in preparation for them commencing their work. The main contractor's site managers, whose responsibility it is to co-ordinate and plan the work, then find themselves with a crisis on their hands. This is the cause of much friction, disruption of schedule and can lead to stressful situations.

The workmen employed by sub-contractors are normally paid on the basis of measured completed work. Earnings for the day or the week depend directly on the speed with which the work is completed. This provides an incentive for every

member of the team to take short cuts.
In addition to the financial benefits, there are often other pressures for quick completion of work, such as to make way for the gang doing the following operation, who might be waiting, or the need to start work on another site.
Speedy sub-contract work is invariably in the interest of the main contractor's site management. There is little incentive for them to interfere with the working methods of sub-contract teams. On the other hand, there is a strong need for co-operation of every sub-contractor with the site management to achieve the overall co-ordination required for the smooth progress of work. Interference is not in the best interest of gaining such co-operation. As a result, in many construction projects, sub-contractors enjoy a high degree of freedom in relation to the way their work is conducted.

2.8 Working Relationships

The main contractor in a project is largely responsible for the co-ordination of the work of many different work teams. This function involves gathering information concerning the on-going work as well as the cues for the co-ordination of future work, the arrival of supplies, labour and plant, ordering ahead etc. In view of the large number of trades and supplies involved in any one project and the extent of sub-contracting, the co-ordination function is one of the most difficult for the site management. The roles and functions of individual participants in a construction team have been found to vary from site to site. Also in most cases, they are not well defined. Higgin and Jessop (1965) concluded: "As a result of this instability and a lack of stable definitions of responsibility for members of the building team, there is a general anxiety among all concerned. This is understandable when from one project to the next, a man may have no idea what his job is going to become. In this situation it is not surprising that relations between the various parties should be often strained and that tensions should exist, and this does in fact seem to be the case".

The collection of participants involved in a particular project invariably formsa unique combination, which might not be repeated in a subsequent project. It takes time for people who are working together to understand one another and establish a smooth relationship. On many construction sites, just as differences are gradually being sorted out by trial and error and some sort of understanding is being reached, some of the parties move out after finishing their part of the work, or the job comes to an end. Any team spirit built up in one project has no opportunity of being capitalised on elsewhere. Hence, the site management and most operatives find themselves working with personnel they are not familiar with on most construction projects.

The various groups of personnel who get together to build a structure using their diverse specialities and skills, have to carryout their individual activities amongst those of others. Although each performs specific operations according to the requirements of the case, they often get in each other's way thereby necessitating adaption, modification and change in their respective activities. The latter requires mutual cooperation. Riemer (1976) concluded that work people negotiate their way through these predicaments. The different groups of workers were found to organise their separate installations through a "negotiated process" and this collectively based "negotiated order" was found to facilitate mistakes at work. Loss of message context, misunderstanding and transfer of ambiguous and inaccurate information were found to occur as a result of transmission of most information by word of mouth. Situations often arise where the problem of allocation of resources is complicated by competitive demands for the same type of manpower or equipment (Nuttall 1961).

2.9 Use of Plant

Topographical, economic and other reasons can restrict the use of the most suitable plant and equipment on any particular site. In the case of some jobs the nature of the site may not permit the admission or the operation of a particular machine.

If the use of the machine is required only for a limited period, or its use is to be intermittent, thereby involving long idle periods or movement over large distances then its use may not be economically feasible. Even where suitable equipment is available, sometimes operatives may not use it if it is necessary to move it over a distance for a job of short duration. Improvisations not envisaged in the design of some equipment, and over extension of their capacity is a high probability in such cases.

2.10 Nature of Site Activities

Construction is an emergent process and construction sites are transitional in nature. The layout and arrangement of activites play an important part in the organisation of construction sites. As work gets underway, the layout and activities keep changing continually, and the planning of the site becomes one continuous problem. This is further aggravated by the fact that many sites have only a limited area available to carryout the large variety of operations required. Internal transport arrangements, stacking and storing areas, need changing and re-arranging periodically. Overloading, overstacking, double handling, overcrowding of too many activities together, are common day to day occurrences on many sites. Complications arise in movement, handling and storing of materials and equipment, when supplies arrive on the site, often not according to the needs or the programme of work. Proper co-ordination between the programme of suppliers and site progress is seldom achieved in practice. On the majority of the sites, initial and progressive planning is done in an ad-hoc manner.

The temporary nature of most construction projects, and the rapid build-up of facilities for the site personnel result in sub-standard conditions of work compared with more permanent establishments. Exposure to weather of most site operations and the nature of certain construction activities, make the work physically demanding. Certain activities require a considerable physical effort, and also are often carried out under fairly rigorous conditons. The performance of construction machines and materials can also be seriously hampered under unfavourable climatic conditions.

2.11 Job Structure of the Labour Force

Construction labour is traditionally divided into three types. The occupations belonging to a traditional craft, where the men are skilled and generally recruited as apprentices, usually soon after leaving school; labourers who are non-skilled and recruited directly as labourers; and the occupations that are non-craft but nevertheless require special skills, such as mechanical equipment operators, scaffolders, steel benders and fixers etc. A striking characteristic of the construction industry, particularly prevalent in the building sector, is the strength of craft traditions within many of the trades. Most of these go back to medieval and even earlier times. The craftsmen are experts in their particular trades and take much pride in their workmanship. It is not easy for the site management to direct or dictate the ways in which such personnel should carry out their work. Although there is a high degree of variation between different projects, generally, construction is considered more labour intensive than most other industries. Studies and surveys carried out on different aspects of construction manpower have highlighted many problems. Jeans (1966) in studying the level of training of building operatives, the range of work they carried out and the relationship between them, brought many points to light. There was a high degree of overlap between the work of trades. A large number of workmen reported doing work outside their trade. Many occupations such as plant operators, who were not drawn from the apprenticeship trades needed systematic training, whilst apprenticeship training itself could be improved. The common activities of a trade's work was undertaken by all operatives, where as only a small proportion of tradesmen did the less frequent special work. He identified 88 different groups of operations in new construction work, and concluded that 86 of these were carried out on one site or another by only eight occupations: carpenter, bricklayer, plasterer, painter, slater, plumber, electrician and general labourer. The industry commonly depends on this arrangement to obtain the flexibility to perform a wide range of operations on one site by the use of a limited number of men.

2.12 Characteristics of the Labour Force

The results of a number of studies and surveys carried out during the last few decades quoted below indicate that the industry's labour force is related to the working conditions found in it. These conditions are largely dictated by the transitional nature of construction projects, transient nature of the work place, constant fluctuations in the demand for a particular service, exposure to weather and the inability to maintain continuous employment with one employer.

Davis (1948) in a survey of 400 workers found that 80% of them liked the job "very definitely". The reasons most often given were "the sense of freedom and open air life", "pleasure in the actual doing of the job" and "the variety that the work offered". A marked pride of workmanship was also noted. The Phelps Brown Committee Report (Great Britain: Ministry of Employment and Productivity and Ministry of Public Building and Works 1968) stated that in 500 essays that the Building

Research Station obtained from apprentices about their attitudes to work, the four reasons most often quoted for obtaining an apprenticeship in construction were: links with the industry through family or friends, a desire for freedom from restrictions, variety and work in the open, and security in a career after completing an apprenticeship. Satisfaction with the content of work was most frequently associated with variety, and dissatisfaction with repetitive work. In social survey interviews in 1965 with building workers (ibid) more than 50% of those who had entered construction for their job gave the "type of work" as their reason for taking the job. These attitudes of the work force were further confirmed by Thomas (1968).

Nelson (1969) and a study by the London School of Economics (Great Britain: Department of Employment and Productivity 1970) discussed the high rate of labour turnover on construction sites and the geographical mobility of the labour force. The continuity of employment which an individual company can offer depends on the nature of its operations and on the continuity and geographical dispersion of its workload. Large civil engineering projects may be undertaken in remote parts of the country making it necessary to bring in labour from outside. The construction worker therefore has to be willing constantly to move from job to job, and the distance which he may have to travel between his home and his job may vary greatly. In view of the practice of recruiting the bulk of the labour force required on a given site for work on that site only, a very high degree of casual employment was found inevitable.

The ILO Building, Civil Engineering and Public Works Committee (International Labour Organisation 1964) referred to the instability of employment as a persistent characteristic of the industry (Great Britain: Ministry of Labour 1967) stated, "While certain individual contractors attempted to instruct their inexperienced employees on site on the hazards they might meet, their efforts were often nullified by the high labour turnover. One of the larger contractors under survey arranged for the safety supervisor to give a site lecture to 300 employees. Four weeks later, there were only 10 men on site who had attended the lecture."

The Phelps Brown Committee Report (op cit) in discussing the engagement of labour, observed that the four main channels through which labour was engaged, were employment exchanges, press advertising, direct contact by the firm and direct advertising at the site. A majority of recruiting was done by informal arrangement. The most common occurrence was for the prospective workmen to inquire directly from the sites. It was also common for the firm, the site agent or foreman to contact known workmen directly. Methods of selection were found to be either totally absent or very unsatisfactory. On the large sites, where the highest rate of labour turnover was noted, most recruitment was done on site. Termination of employment was found to be comparatively easy by either the workmen or the site management. Although the formal responsibility might rest with the site agent, in practice, it was common for the trades foremen or the gangers to hire and fire within their own group.

It was evident from the above surveys and studies that by a process of natural selection, construction workmen are likely to be rugged types of individuals who prefer to work in the open air and who value variety, freedom from restriction and independence. These seemed to compensate for the unfavourable working conditions which exist in comparison with other industries.
The majority of the work force was attracted to the industry because of the freedom it allowed for change - change of employer, the types of work, and the working surroundings. Most skilled craftsmen had the opportunity to work independently with minimal or no supervision. Controlling the activities of such personnel is likely to demand special considerations and pose many complicated problems forthe site management. The casual nature of employment of many operatives and the very high degree of labour turnover inhibit the growth of proper understanding, mutual responsibility and loyalty between the line management and operatives. This further aggravates the situation.

2.13 Incentives

Over the years, there have been many forms of incentive schemes aimed at achieving higher production, and attracting labour to the construction industry. In 1947 an agreement between the employers and the unions in the building industry formalised this procedure by accepting that where operatives increased their productivity beyond a defined and agreed level, they should be entitled to additional payment beyond the standard rate. Entwistle and Reimers (1958) established the general principles essential for the successful operation of incentive schemes. A very common scheme operating widely is that of 'letting' work as piece work. This system also manifests itself as labour only sub-contracting and as self-employed workers. The Phelps Brown Committee Report (1968) (op cit) stated: "Where it works best, labour-only sub-contracting combines the contribution of the specialist sub-contractor to the organisation of production and continuity of employment of work with a simple and effective form of wage incentive. To these may be added the high morale of a stable working group and an opportunity for the enterprising worker to gain independence. All these lead to higher productivity. At its worst, labour-only sub-contracting produces faulty work by irresponsible men concerned only with wresting the greatest possible gains from the industry in the short run, and unrestrained by their own standards or by the control of management". It is common belief that unless a high degree of supervision is enforced on this type of scheme, there is a definite risk that quality may suffer, safety precautions be ignored, plant be abused and materials wasted. Haste causes neglect of safety precautions, particularly, if adopting them takes time or involves additional work. It also causes problems such as cluttering of materials, obstruction of access and overloading of temporary structures so as to ensure adequate supplies within easy reach. The system also upsets construction programming for many reasons. For example; workmen choose their own times of work, thus disrupting planned work.

2.14 Summary and Conclusions

There are large variations in the nature, environment, labour force, and work climate on different sites and on the same site at different stages of construction.

The methods, procedures, and organisation of the industry have needed to develop with sufficient flexibility to meet the demands made on it, that is, to provide a unique structure in a unique location for the unique requirements of a client. This flexibility has been found to result in a degree of disorganisation. An information system, far removed from the formal system, and a negotiated social order were found to exist.

A large variety of forces beyond the control of the site organisation have been found to contribute to the uncertainty within the site. These also cause disruption to the smooth progress of the work.

Resources are dispersed amongst different participants and brought together according to the needs of a particular project. The workings of different groups and individuals engaged in a diversity of activities are based on their own objectives rather than those of the main organisation.

The responsibilities and functions of these parties are not clearly defined and the nature of their relationships is uncertain. Their approach to work is based primarily on the specific results to be achieved rather than on the functions to be performed, and the means and methods of achieving the results are mainly left to the discretion of the individual worker.

Difficulties that the contractor's organisations face in acquiring the space, skills and resources necessary for a project at short notice, the sudden build up of the skills and resources in a limited space, and continuous changes in them with the progress of work, can result in a sub-standard form of site organisation. The site management has to take decisions on complicated problems in a short time on the basis of inadequate information and many uncertainties.

The high level of competition involved in winning contracts, the deadlines imposed in them for completion of the work and, incentives and payment methods in the industry, impose pressure upon management as well as work force to conduct their work in a hasty manner.

Instability of employment, high labour turnover and the temporary nature of recruitment predominant in the industry inhibit the growth of mutual responsibility and loyalty between the line management and the work force.

The work requires a considerable physical effort and is often carried out under fairly rigorous conditions. To most construction operatives, freedom of choice, independence, variety of work, a low level of restriction and open air work seem to compensate for the unfavourable working conditions in comparison with most other types of industry. The type of individual employed in it, and the ways in which it functions, create special problems as regards site safety and supervision.

CHAPTER 3

SITE SUPERVISION IN THE CONSTRUCTION INDUSTRY

3.1 Introduction

This chapter describes the aspects of site supervision in the construction industry which are of importance to this research. It forms the background essential to gain a clear understanding of the job of a construction supervisor in relation to safety on sites. It thereby assists in forming a clearer picture of the problems under investigation, as well as providing guidance towards the most suitable research method and approach that needs to be adopted. There are very few studies which have been done on the subject of site supervision in the construction industry. Most of the available literature applies to the production or maintenance supervisor in general manufacturing industries. Therefore, this chapter draws heavily from such studies and the personal experience of the researcher.

3.2 The Site Supervisor

The site supervisor in the construction industry forms a part of the line management team in the site organization. His job is concerned with all or some of the activities involved with the construction phase of a project and he is employed by a client organization which itself has undertaken to do the construction, or by a main or sub-contractor who has undertaken the whole or a part of the construction works. Some employers of gangs of labour do the supervision themselves on certain contracts that they undertake, in which case the supervisor is not an employee.

Site supervisors are usually site based, but in the case of very minor construction works, they can be based off-site with responsibility for a number of projects. Some supervisors who are in charge of specialist services may supervise different gangs of workmen on different sites, again from an off-site base.

Depending on the size and nature of the works and the policy of the firm, there can be one or more levels of supervision on the same site. The different levels may be seen parallel to the categories identified by Thurley and Hamblin (1963) and by Thurley and Wirdenius (1973) as

(i) the second-line supervisor

(ii) the first-line supervisor and

(iii) the semi-supervisor

The highest level of management on a site is the man in charge of the site. He is commonly known as the site agent in larger sites and general foreman or foreman in smaller sites. The same individual may occupy the first line or second line supervisory or the top site management position in different sites of the same firm, or at different stages of construction of the same site. The quality of the supervisor, his distribution of responsibilities and the mutual loyalty between employees also depend on the plicies of the firm. It is therefore difficult to assign a particular status, position or description to all construction supervisors.

The personnel, activities, plant and equipment, and the construction setting, that are being supervised by a particular individual all keep changing from site to site, and one stage of a project to another, and often from moment to moment, with the progress of work. The extent of the differences between various supervisory situations of a single supervisor, can therefore be enormous. A particular set of tasks cannot be identified as common to all supervisory situations. The problem is further aggravated by the fact that a large number of different titles is commonly applied to supervisory positions. They include Works Superintendent, General Foreman, and the terms Foreman, Supervisor, Chargehand and Ganger used along with the name of a particular trade (eg. Foreman bricklayer, Foreman carpenter, Concrete ganger etc.) or along with other prefixes such as site, jobbing, visiting and terms describing a section of supervision. In the majority of cases, the job titles are not attached to formal job specifications, and hence do not provide a precise indication of the functions or activities of a supervisor. This seems to be true for supervision in many other industries too. A study conducted by the NIIP (National Institute of Industrial Psychology 1951) found at least 200 different job titles used for personnel considered as supervisors.

A construction supervisor can therefore occupy varying levels of status, authority and responsibility, can be performing any of a wide variety of tasks in a particular job, which may vary from time to time and may have one of a large variety of job titles. Thurley and Wirdenius (1973) stated: "In this sense a supervisor's job appears to be a type of empty box, to be filled with activities and tasks according to the particular situation". This description seems very appropriate to the job of a construction supervisor.

3.3 Nature of Supervision

In the literature, there are many different attempts to define the terms "supervisor" and "foreman". It seems common to use the term "foreman" to describe the supervisory position associated with some occupations (an occupational term), whereas the term "supervisor" is used as an organizational term applicable in general. The following are some definitions found in the literature.

i. "A supervisor is a person in constant control of a definite section of a labour force in an undertaking, exercising it either directly or through subordinates and responsible for this to a higher level of management." (Great Britain: Ministry of Labour 1954).

ii. "Throughout the report the word "foreman" is used to mean the men and women in industry who are in charge of a production or maintenance unit and who are in immediate daily contact with the operatives whose work they direct and control." (Grabe and Silberger 1956).

iii. "The definition of "supervisor" used in this study is based on the theory that the purpose of management is to control the operatives and the operations on the shop-floor. This control can be exercised in two ways: first, by administrative methods,ie at a distance; and secondly, by actual 'overseeing', inspection and direction in the area of operations. A "supervisor" (as distinct from a purely administrative manager) is someone who exercises control by the latter method." (Thurley and Hamblin 1963).

iv. "By foreman we mean an employee who has been appointed by management to see that its plans for any particular organizational unit within a company are carried out, by directly leading the labour force (often employed according to collective agreements) of the unit in question. When the employee accepts this appointment, he at the same time becomes responsible to management for the functioning of the unit. The foreman rarely performs work of the same type as his subordinates, and only in cases of emergency and for instructional purposes." (Westerlund and Stromberg 1965).

These definitions, taken together indicate that supervisors in general exercise control, direction and authority over a section of the work force by the methods of overseeing and inspection; are in daily contact with these people; are responsible to a higher level of management for the proper functioning of a unit that they are in charge of; occupy one level of a supervisory hierarchy; and may, in certain special cases, perform work of the same type as their subordinates. These points together seem to describe the job of a construction supervisor, although with a wide degree of variation with respect to the type and extent of application.

However, these definitions are only attempts to provide a very short and precise description, in an extremely general form, of the job of a supervisor for purposes of theoretical discussion. In the practical sense, the variations between the specificities of these general descriptions can be very large. This variation rarely creates difficulties for any category of personnel in a site in recognizing who the supervisors in the site are, since they have their specific characteristics in that site. The problems of recognition and distinction are largely theoretical, because the variation does not permit a meaningful classification for purposes of description and analysis. The implications for this research are that each supervisory job can be described only in the context of the specific circumstances of the situation. Generalisations about "the supervisory job" have limited value. Also in view of the dynamic nature of the role of the construction supervisor, which largely depends upon the prevailing circumstances, an investigation has to include, in addition to the observed facts of actual behaviour, the reasons and circumstances leading to such behaviour. It will also need to highlight the influences (eg. from organizational, social, economic etc factors) which were instrumental in producing and affecting that behaviour.

3.4 Studies on Supervision

Those studies on supervision that are based on a general set of duties and functions of supervisors, do not take into account the varying nature of the job, and the occurrence of unpredictable events which need to be dealt with from time to time. Many case studies of supervisory work have emphasized the fact that coping with disturbances of varying nature, and frequent occurrences of unpredicted problems are among the most important activities of a supervisor's job. Thurley and Hamblin (1963) in a study of several manufacturing industries pointed out that dealing with disturbances and unexpected problems formed a critical part of a supervisor's functions. Marples (1967) used the concept of contingencies to describe supervisory work as a collection of problems and disturbances. The degree to which they formed a part of the job ie. the frequency of occurrence and the degree of their influence has been found to vary greatly from the well planned situations where the tasks are specified and programmed in advance and the crisis situations where problems are handled as they come. Construction works by their very nature have been found to make the individuals working in this industry subject to a variety of contingencies. Docherty (1971) concluded that the many forms of uncertainty in the construction situation result in the work of individuals being highly prone to interruptions from contingencies, and that these contingencies could be used to study the organizational and administrative problems facing a company or an individual. It was therefore important that for the present study to be valid it should incorporate in its model this dynamic nature of supervision and the continuous pressures due to unexpected disturbances.

Thurley and Wirdenius (1973) stated that the most fundamental error in studies of supervisory effectiveness, was the search for general measures which could be applied to all supervisory situations. The effects of supervisory actions have been found to depend on the way in which the many different variables are present at a particular point in time in a particular production system. The implication of this is that a selective study limited to problems and crucial pieces of supervisory behaviour on a case by case basis, is likely to provide a much clearer picture than any general approach.

Dubin et al (1965), in discussing much of the American work on the effectiveness of supervision, stated that "Supervisory behaviour affects the productivity of individuals by being appropriate to the work setting." They also stated that there is no "one best" method of supervision; only a variety of methods suitable in different circumstances. Hence it was considered essential in this study to develop a method that was appropriate to investigate individual cases from a variety of supervisory situations and circumstances. The present day supervisor, unlike his very early counterpart, is much dependent on and greatly influenced by various elements of the organization. The work force also is subject to many organizational pressures. Westerland and Stromberg (1965) concluded that, in reality, there may be very little possibility of the supervisor influencing the performance in many areas of the work of his subordinates. Studies on the evaluation of training have further emphasized the importance of the organizational climate (Hesseling 1966). A study by Sykes (1962) confirmed that there could be considerable conflict between the values and beliefs imparted through training to supervisors and senior management. Handyside (1956) also showed the influence of organizational factors compared with the training effect. The way a supervisor perceives such organizational influences and the methods of coping with them are instrumental in determining his behaviour, and therefore must be included in any investigation.

3.5 The Background of a Supervisor

As in most occupations supervisors have to possess a suitable background before being appointed to that job. In acquiring this background they go through a long process of being influenced and shaped into a certain pattern of behaviour. There is also a reciprocal process of learning and adaption by the individual. This background serves to provide the ability to perform supervisory functions as well as to gain the identity to be recognized by others as a supervisor. The pattern of behaviour and the attitudes gained during this process are bound to have a major influence upon the individual's ultimate behaviour as a supervisor.

Traditionally a vast majority of construction supervisors are personnel with long experience as skilled craftsmen. Comparatively very few are promoted from labourer status and a few others are directly recruited on the basis of technical qualifications. Experience in the type of work that they are to supervise has long been a popular criterion of selection for supervisory positions in most industries. For example, the National Institute of Industrial Psychology (1951) found that in a large majority of the firms studied, senior managers seemed to value experience of the shop floor and practical know-how for selection rather than training or formal paper qualifications. The sequential process of gaining entry into the industry as an apprentice or labourer, the initial period of gaining experience and working as an experienced workman all contribute towards the type of supervisor one would ultimately make.

I) Entry into the Industry

The reasons given by a large number of construction workpeople as to why they selected a career in the construction industry were discussed in chapter 2. It was found that generally individuals with certain personality characteristics (eg. those who liked freedom from restrictions, independence, open air work etc.) were attracted towards a career in this industry. It is possible that these characteristics form the background to most supervisors promoted from operative grades.

II) On-the-job Experience as Workmen

The primary vehicle for learning a trade or craft in the construction industry is the apprenticeship. The notion of apprenticeship existed during and before the craft guilds of medieval Europe and has a long tradition as a form of occupational training, as discussed by Krause (1971) and Douglas (1948). An apprenticeship usually involves a combination of classroom and on-the-job training. There are other roads to trade status than apprenticeship, such as the Government Training Centres, the forces, an improvership and picking up a skill on-the-job. The main form of training for non-craft labour is on-the-job experience, although courses are conducted in the Government Training Centres for some non-craft occupations which need special skills.

Apprentices and other inexperienced workmen traditionally learn the skills and techniques of their chosen careers from the older and experienced workmen. In addition to the methods of carrying out specific activities, such as the use of tools, techniques of operations, co-ordination of activities among

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workmen etc., they also learn to react and adapt their behaviour to different demands. For example, they learn how to speed up work by cutting corners, how to perform the job even when the necessary equipment and material are not there etc.. Behaving generally according to the established expectations and identity attached to that occupation also would be crucial. There are therefore inherent characteristics which form a part of most supervisors' previous work background, that can have a marked influence upon his expectations of the behaviour of the work force.

III) Occupational Socialization as a Supervisor

Having become a construction supervisor, there is much pressure upon a person to conform to certain expected ways of behaviour within that occupation. In order to establish an occupational identity he has to learn to identify himself with that position by following the ways of other supervisors. Together with the background experience discussed above, this process of occupational socialization is likely to dominate his approach to work. The ways in which the background and the process of socialization affect the behaviour of the supervisor towards safety needs to be examined very closely.

3.6 Supervisory Training

Interest in supervisory training seems to have been initiated by the need for improved production in the increasingly competitive industrial atmosphere and to help the supervisor cope successfully with the changes required in his role and functions. The role of the industrial supervisor has changed drastically over the years with various changes in the industrial and social climate. Child (1969) discussed this change in detail. The early supervisor at the turn of the century was in complete control of the work group and activities in his charge, in far less complex organizations and could be described as the man in charge. His position was associated with certain innate qualities, headed by leadership. In those days, training was considered irrelevant for supervisors, in the belief that supervisors were born and not made. With the application of Taylor's (1911) concept of functional formanship in the 1930's and the growth of the trade union movement, the position and the role of the supervisor underwent radical change. At the same time industrial organizations became more and more complex. The idea that 'supervisors can be trained' started gradually to be accepted. A set of new ideas on 'human relations' in connection with supervisory functions, generated by the Hawthorne experiments (Roethlisberger and Dickson 1939) had a marked influence on supervision and supervisory training. Many writers, for example, Arensberg (1957) have pointed outthat the subject of human relations dominated supervisory training between 1945 and 1955. Short courses were made available for supervisors from widely differing industries and firms in the belief that supervisors required 'common knowledge and skills' in their jobs, no matter what job or whom they were supervising.

The bias of supervisory training towards human relations skills was attributed to the fact that many firms considered that personal leadership based on human understanding was more effective than discipline by sanctions (Likert 1961). Also the take over of personnel and other functions by specialist departments, led to the belief that the only tasks left for the supervisor were those related to the control and direction of labour. The change has been crudely described as a process of evolution from 'boss' to diplomat (Great Britain: Ministry of Labour 1966).

The Training Within Industry programme introduced in the United Kingdom in the mid-1940's was a pioneer exercise in supervisory training, and had a marked influence on the ideas in this field. At the beginning, the Ministry of Labour provided three T.W.I. courses in standardised form dealing with human relations, elementary work study and methods of teaching and instruction. A course of job safety was introduced in 1957 and another in office supervision still later. Many other types of formal training, such as internal company training, training by consultants, and training by technical colleges and other types of institutions were also made available to supervisors at the time. Hamblin et al (1963) found that human relations was still the most frequent subject of supervisory training at the time. However, on-the-job training was considered the most important form of supervisory training, (Thurley and Hamblin 1963) although in a large majority of cases this training was given informally. The Barnes Committee Report (Great Britain: Ministry of Labour 1962) stated that "As training should fit the needs of a particular job, the major part should be undertaken by and within the firm". By 1964, the need for supervisory training of some kind was almost universally accepted by official bodies and larger firms. The view that training should suit the nature of the job and the needs of the supervisor in order to be effective was expressed by many writers (King 1964, Thurley and Hamblin 1963). In order to achieve this, they advocated the use of job analysis methods. The concept that supervisory jobs in different settings were fundamentally similar was questioned by Woodward (1958). She pointed out that supervisory jobs consisted of a large range of technical, administrative and social activities which had a wide variation from industry to industry, company to company, department to department and even from shift to shift. This variation also was found to be influenced by the personality and methods of the individual supervisor, as well as the managerial style of his superiors. This further reinforces the view that a study of the supervisory role must consist of a detailed study of particular jobs in particular settings.

3.7 Supervisory Effectiveness

In general, supervision is concerned not with completing any operations by the supervisors themselves, but with influencing, assisting, and enabling others (the work people) to carry out the necessary work. One of the biggest problems in investigating the job of a supervisor is the absence of straight forward criteria for assessing his performance or measuring the effects of his actions. Studies that have been carried out on supervisory effectiveness highlight this problem. Such studies in general use a design whereby performance variables at the local or organizational level are correlated with descriptive variables concerning work behaviour, individual characteristics and the work situation.

Thurley and Wirdenius (1973) identified the limitations of research designs of studies on supervisory effectiveness. They concluded that few studies were designed to gather comprehensive data on the work behaviour of supervisors in the situation studied. Most studies were extremely selective in the type of variables chosen for measurement, perhaps partly because the researchers considered that the only possibility of controlling the study was to concentrate on relatively few variables and partly also because they underestimated the complexity of the problem. Another deficiency of most of the studies was that they were working with a concept of the individual supervisor rather than with any understanding of supervision as a type of social system. The lack of a comprehensive approach has led to attempts to isolate the supervisor and his section and examine the relationship between supervisory descriptions (eg the style or dimensions of leadership) and the corresponding performance of work groups. (Fleishman et al 1955, Kahn et al 1953).

Such attempts make the assumption that there is a direct relationship between the supervisory actions and the worker performance. However, as pointed out by Westerlund and Stromberg (1965) this may not be true. There can be many influences apart from supervision which can effect the performance of those who are being supervised. Similarly, supervisors may influence many aspects of the organization other than the persons under their supervision. Operative performance alone, therefore, is not a proper criterion of supervisory performance; nor are many of the other criteria commonly used to measure organizational performance, such as indices of absenteeism, labour turnover, accidents etc.. One method of overcoming this problem is to first identify specific characteristics indicating success or failure in a particular supervisory workplace taken as a whole, and then to establish how it is related to the behaviour of the supervisor in that particular organization and its existing social system.

3.8 Leadership Behaviour and the Style of a Supervisor

There is much interest in the supervisory literature in linking the qualities or characteristics of the supervisor with the performance of work groups. Leadership behaviour and style of the supervisor have been very popular qualities used in these studies (Argyle 1957; 1958 ; Kahn and Katz 1953 ; Sales 1966). The interest in leadership was based on the argument that the formal role of behaviour of management is based on a leader-follower relationship between the manager and his subordinates. Many studies of leadership have therefore focused on management personnel in view of their formal positions. These studies provide much insight into supervision, although the mass of literature available in this field is marked by doubtful and ambiguous relationships between leadership style and a variety of organizational criteria. (Korman 1966, Kerr and Schriesheim 1974).

Hill and Hughes (1974) concluded that leaders change their styles in response to situational conditions. Lowin and Craig (1968) showed that leaders change their style in response to the behaviour of subordinates. Hill (1973) showed that leaders are not perceived by subordinates to have 'one style'. It is therefore clear that no one leadership style is effective in all situations, and a variety of leadership behaviour may be equally effective in the same situation.

Some of these studies have shown that formal leaders in organizations carry out a large number of activities, most of which are of short duration, and are carried out at a hectic pace. Ponder (1957) showed that foremen averaged between 200 and 270 activities per eight hour day. Mintzberg (1973) observed that a manager's activities are 'characterised by brevity and fragmentation'. Morgan and McCall (1976) in a review of leadership literature stated that each of the huge number of activities in a manager's day could be interpreted as a different situation, and that the implication of most current leadership theories was that the greatest effectiveness was to be achieved by applying the correct style in each situation. This again points towards the need to assess each case on its own merits.

3.9 Influences of Higher Management and Organization Structure

Supervisors carry out their functions within organizations that are of varying types. The goals and norms for the functioning of the system as a whole and its various subsystems and components are sanctioned by higher management.

They include mechanisms for social control and feed back circuits in order to ensure adherence to the norms and attainment of the goals. Supervisory activities take place within the boundaries thus set. Evaluation of the job behaviour of individuals, the ways in which they conduct their functions and laying down behavioural criteria, are questions directly related to the structure of the organization. These activities can be viewed either as constraints upon the employees motivation and freedom of choice and therefore more harmful than beneficial, or as providing meaning, organization and clarity, thereby facilitating their work.

There is a wide belief that both workers and managers work most effectively and with more satisfaction, when they have maximum autonomy over a whole task, either individually or as a group (Rice 1958, 1963). This implies that they should be free to decide the organization of the tasks and the ways in which the tasks are carried out. It also suggests that their performance should be judged by the results, rather than the ways in which they are achieved. The philosophy of management by objectives, described by Humble (1970) also follows the view that managers should be judged by results rather than by their actual behaviour. This approach is supported by the idea, primarily associated with the names of Argyris (1964, 1957), Likert (1961), and McGregor (1960), popularly known as 'Theory Y'. Briefly, this states that organizations should be designed to permit the self-fulfilment of their members, and that the structure of most organizations which follow the classical management theory and consist of task specialization, clear authority channels, hierarchy of authority, closely defined roles etc., severely inhibit the extent to which the individual can achieve self-actualization. The present day interest in job enrichment and employee participation, (Paul and Robertson 1970, Taylor 1972) (Emery and Thorsrud 1969) is also based on this and similar theories.

The belief that structure is beneficial to both individuals and organizations is also widely held. Burns and Stalker (1961) quote managers in organismic type of organizations who found the lack of clear definition of responsibility and of authority a source of uncertainty and anxiety. This is considered as an inescapable ingredient of adaptation to change. Structure is found to provide individuals with boundaries and an element of certainty which is beneficial to their work lives. Jaques (1951) and Brown (1960) found that clearly defined roles were frequently preferred and were important in averting confusion and anxiety. Cohen (1964) pointed out that people experience in varying degrees the need for structure and clarity at a cognitive level. Kahn et al (1964) found that people with a high need for cognitive clarity were more likely to experience job tension when faced with job ambiguity.

Woodward (1958, 1970) Burns and Stalker (1961) and Lawrence and Lorsch (1967) have pointed out that those organizations which are successful or effective have an organizational structure which is congruent with their environment. They insist that there is no 'ideal' organization only a variety of organizations suitable to different circumstances.

Burns and Stalker (1961) defined a continuum of levels of formalisation in the structure of organizational systems, the opposite poles of which are represented by organizations called "purely mechanistic" (also known as theory x / authoritative / bureaucratic) and "purely organismic" (also known as theory y / participative / non-bureaucratic). The former are characterised by an extensive code of formal rules to direct and control the operations and working behaviour of individuals, as well as detailed specifications of duties, powers and functional conduct attached to each position. These are considered eminently suitable to situations of stability and routine in which the rate of change is rather slow. On the other hand, the latter are characterised by a lack of such formal specifications, wherein the components function and interact through a process of continual adjustment so as to accommodate the instability of a changing environment. These, in view of their greater adaptiveness, are considered appropriate to unstable, rapidly changing circumstances. The degree to which rules and procedures are defined and functions and interactions are regulated decides the position of any particular organization on this continuum.

In view of the rapidly changing conditions, the high degree of interdependence of the organizational components, and the uncertainty in construction projects, discussed in Chapter 2, it is likely that most construction site organizations, in order to be able to adapt to and cope with unforeseen and unforeseeable events, will in general, have to acquire a type of structure at the organismic end of the mechanistic-organismic continuum. This view is supported by the study of Docherty (1971). As pointed out by Weick (1974), the degree to which organizational components are interdependent is itself a variable.

As a means of adapting to the variation and unforeseen events, there is more reliance on the innovative skills of individuals, than on the rules and procedures of the organization. The behaviour of individuals in such circumstances is likely to be greatly influenced by the way they perceive the situation and their individual reaction to it. The form of training appropriate to such circumstances also needs to be examined carefully. Merton (1957) argued, for example, that to define tasks and procedures in detail and to train people narrowly and intensively to perform them might render them (the people) incapable of adjusting easily to change.

A lack of rigid boundaries between sections and functions tends to make people think in terms of achieving goals, rather than of carrying out functions. This and the desire of construction people to maintain independence and the freedom to decide the way they work, is likely to impose a system, whereby their performance is judged by results rather than by behaviour. In such an environment, the way the supervisory decisions are made in circumstances where it is desirable to lay down behavioural criteria (eg. enforcement of high safety standards) needs to be investigated closely. It is vital to note that this has very important implications as regards training of supervisors. Training objectives are set according to the functional requirements and goals of the individuals. If these keep changing, then the training has to change with them. The continuous change and uncertainty of events require the training to be continuous and at any one time to be specific to the existing goals and functional requirements. Also the results or goals orientation, rather than functional orientation of personnel requires an evaluation of their work to be based on goals at their behaviour levels which are defined in terms of the work objectives of the personnel.

3.10 Objectives: Organisational and Individual

Hepworth (1972) suggests that all organisations have four primary objectives in the following order of primacy:

1 Survival of the organisation
2 Creation of surplus money (profit)
3 Welfare of interested parties
4 Social/political welfare

This is however an oversimplification of the situation. In the actual process of a particular production activity, these will be translated into more tangible goals pertaining to that activity eg. producing a product of certain characteristics and quality, achieving a certain minimum production rate, achieving a certain minimum rate of labour turnover, absent-eeism, accidents, wastage etc. Performance of the organisation is judged by these objectives. But as Sayles (1964) pointed out, in practice, supervisors cannot be judged by results relating to these objectives, because they take so long to appear, and the links between the supervisory actions and the results are far from clear. Therefore, a distinction needs to be made between the organisational objectives and the job behaviour objectives of the individuals. The former is concerned with the extent to which the organisation achieves its ultimate goals and the latter with the ways in which the organisation works. The work of the supervisors and the work groups are influenced by their own objectives and their own priorities. The overall organizational goals need to be translated into local terms to see how far they have been achieved, and detailed investigations need to be carried out in terms of the local objectives of performance. In the organization of a construction site, because of the rapidly changing circumstances, it is necessary to do this translation of objectives on an on-the-spot basis.

3.11 Summary and Conclusions

In the construction industry, supervision involves a large variety of activities. The work environment and the functions of an individual supervisor keep changing constantly. Any description of supervision in isolation from the particular situational context is therefore not meaningful.

Supervision is much too complicated to be studied solely on the basis of the relation between the supervisor and his subordinates. Supervisory effectiveness also involves a variety of factors other than the performance of the work group. Observing behaviour is not sufficient for an understanding of supervision. Research must include ways of understanding how the supervisors decide, evaluate, view and assess their own behaviour.

Most construction supervisors come from amongst the construction work force. The influence of occupational socialization in a construction career on the supervisory behaviour towards safety, needs to be appreciated.

Supervisory training should suit the nature of the functions and the settings in which they (the functions) are carried out in order to be effective. The constantly changing behavioural objectives and training needs should therefore be monitored continuously.

Studies on leadership behaviour related to supervision indicate that there is no one style of behaviour effective in all situations and that a variety of behaviour may be equally effective in the same situation.

In order to accommodate the unavoidable continuous change on construction sites, it was considered that, in general, most site organizations are likely to have adopted a type of structure towards the organismic end of the mechanistic - organismic continuum. The performance of individuals in such organizations tends to be seen in terms of achieving results rather than carrying out functions. There are also limitations to the degree to which the work behaviour can be controlled by introducing a more rigid structure. The implications of this as regards supervisory behaviour towards safety, needs to be looked at carefully.

The organizational objectives are distant from the behaviour objectives of the individuals. A translation of the organizational goals into local objectives of performance is essential for a study on the safety role of the supervisor.

In research on construction supervision, it is essential that the technique adopted is able to identify and investigate the relevant contextual factors specific to each case. Developing methods of dealing with the individual circumstances is more important than drawing up manuals of role description.

CHAPTER 4

SAFETY IN CONSTRUCTION

4.1 Introduction

This chapter describes the concepts, views and methods that are of relevance to this study as regards safety in general and construction site safety in particular. It highlights the important issues and the present state of knowledge and practice, thereby contributing towards a fuller understanding of the field of study as well as providing guidance towards a suitable research technique.

4.2 Public Concern for Safety in Construction

Taking risks is an inherent part of most human activities. Hazards or possible causes of harm are found practically everywhere. Pursuing a trade or an occupation in an industry exposes people to a set of hazards often peculiar to that particular industrial activity. In an industry such as construction with a history of thousands of years, people have no doubt always made attempts to reduce the numerous hazards met therein. However, a systematic effort to understand and deal with hazards in industry has been made only in recent years. The concern of society as a whole for working conditions in different types of industry is a relatively new development. The involvement of the United Kingdom government in regulating conditions of work began in the early 19th Century in a very limited way. This occurred mainly in response to the demands of social justice, towards the pauper children employed in textile mills who had to work long hours under appalling conditions. Hutchins and Harrison (1911) describe this beginning and its development in detail. The strategies of compulsory notification and investigation of accidents, and the setting up of expert inquiries into individual industries brought to light new problems which were dealt with by regulations and standards, individually as and when they were recognised. It took a much longer time to acquire a proper understanding and knowledge regarding the accident risks and methods of control in the construction industry, than in most other industries. An attempt to provide a comprehensive set of regulations to cover all construction activities was made only as recently as the 1960s by the introduction of the following sets of regulations under the Factories Act 1961.

Construction (General Provisions) Regulations 1961 (S.I. 1961 No. 1580)

Construction (Lifting Operations) Regulations 1961 (S.I. 1961 No. 1581)

Construction (Working Places) Regulations 1966 (S.I. 1966 No. 94)

Construction (Health and Welfare) Regulations 1966 (S.I. 1966 No. 95)

In recent years, concern of the public for health and safety at work has increased tremendously. This was also mainly a result of the Robens Committee Report (Great Britain: Department of Employment 1972) and the radical changes subsequently implemented by the introduction of the Health and Safety at Work Act 1974. Consequently there is likely to be a demand for changes in the ways in which the construction industry works.

4.3 Accident Data

Retrospective data concerning accidents of a defined type have been extensively used for the purpose of understanding various aspects of safety in industry. Statistical treatment of data to evaluate frequency rates, severity rates, time lost, costs, etc, and to investigate the relation between accidents and various other factors (such as types of industry or activity, personnel, environment etc) has thrown much light on this problem. Such studies have pinpointed areas which need looking at in greater detail, suggested the need for improved preventative and/or control measures, provided guidelines for the choice of priorities, and added a wealth of information upon which much of today's safety activity is based. Statistical studies, however, suffer from the inaccuracies of the data available for this type of analysis. Such inaccuracies may result from incomplete and/or incorrect reporting due to various social, economic and personnel reasons, and the limitations imposed by the definition of reportable events.*

These shortcomings have been widely discussed (Shipp and Sutton 1972,Great Britain: Department of Employment 1972, Senneck 1974).

Shipp and Sutton identified two main types of information on accidents:

(a) Specific and quantitative information to be used as a measure of performance. This is also used to study trends in specific situations and to make comparisons between different situations to provide guidance for policy decisions.

(b) Descriptive and comprehensive situation-based information to be used as a basis for developing expertise. This can identify the dangers and problems of specific situations, and can then

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* See footnote on page 11 for the definitions of reportable events.

be used to develop methods of preventing or controlling these events and their consequences.

The first type of information has value where gross assessment of an industry, an organisation or a situation is required for purposes such as evaluating the overall effects of a particular safety programme, or finding areas which warrant more or less attention etc.. The second type of information is needed for the developing and implementation of preventative and control techniques to deal with many types of situations faced in the industry today.

The development of hazard control measures in the construction industry has been to a large extent based on the past experience gained by means of the two types of information mentioned above. The vast collection of such measures dealing with almost every type of accident in this industry today, is the result of a somewhat haphazard buildup, whereby, a particular type of accident has initiated a corresponding control measure on the basis of its failure characteristics. Investigation of accidents has played a major role here. The recommendation of preventative and/or control measures against recurrence is a main objective of detailed accident investigation. It involves a careful examination of the "causes" behind the event and the development of methods of removing, controlling or limiting the consequences of a similar event.

4.4 Accident Causation

Safety activities in industry have been based extensively on a "causal model". This concept holds that it is possible to influence accidents and their consequences by identifying and dealing with their "causes". A simplistic definition of causation is that every effect has its single cause. Baker (1954) stated that it had been customary to name a single factor as the "cause of the accident", which usually happened to be either the easiest factor to discover, or the easiest to control. Heinrich (1931) stressed the importance of multicausality in accidents and postulated a chain or sequence of events leading up to an accident. His theory is widely known as the "domino" - theory. He suggested that this sequence followed the stages of 'ancestry and social environment' leading to a 'fault of person' constituting the 'proximate reason for an unsafe act and/or mechanical hazard', which resulted in the accident, leading to the injury.

The concept of "contributing conditions" has often been suggested as a more suitable form of causation. A study by Blumenthal and Wuerdemann (1968) concluded that, "the request for 'contributing conditions' ignores the same logical and procedural difficulties as the request for

'the cause' or 'causes' of an accident. The investigator can identify only those factors that are available to relatively superficial observation and that are close to the accident in time and space". Blumenthal (1970) suggested a concept of a causal structure consisting of four levels. At the first level, "accidents" are considered as symptoms of a malfunction of the operating system. At the second level, is the operating system where human and/or material capabilities were exceeded. The third level is the management decisions which were inadequate where failure in conception, design implementation, operation or modification of the operating system occurred. At the last level, is the absence of adequate-knowledge or the allocation of higher values to other system outcomes over safety, which resulted in the inadequacy of the management. This concept is similar to the many phases of the ecological relations of the disease process encountered in the causal models of disease.

Susser (1973) stated:

> "The number of causes implicated depends in part on the frame of reference of the investigator and the scope of his inquiry, that is, on the conceptualisation of the study. Concepts and the frame of reference determine the causes we seek.............
>
> To choose a frame of reference is to choose a limited set of causal relationships within an ecological system. The choice is the outcome of the needs and consciousness of an investigator in a particular situation, but on logical grounds it is an arbitrary procedure. The specificity of one-to-one relationships can only be attained by such arbitrary procedures."

The frame of reference and concepts chosen therefore play an important part in the type of 'causes' relevant to a particular study. The primary interest of the study described in this thesis is concerned with the operating system level of Blumenthal's causal structure, because it is at this level that the supervisory role, exists. Inference of causal factors by studying accident details also depends on a number of things other than the concepts and frame of reference of the investigator. The degree of existing and available knowledge, the experience and approach of the person who makes the inferences, and the level and degree of information collected, are some of them. The variability of these factors and their changing nature can result in different causes being suggested pertaining to similar incidents on different occasions.

A causal model is deterministic. However, factors that have been identified as 'causes' of previous accidents often do not result in accidents every time they occur eg. accidents do not happen every time an unguarded machine is operated. Also, accidents can happen when known 'causal' factors are absent eg. occurence of certain cases of cancer without any of the known causal factors being present. Therefore, a more accurate statement of causation is, that the presence of a 'causal' factor increases the probability of the event.

4.5 Hazard Control in Industry

A vast majority of the measures available and in practical use in industry today are based on the process of extrapolation from the past to the future, wherein causal factors identified in previous situations are controlled or dealt with to reduce the chances and effects of future accidents. However, there is a variety of ways in which a particular hazard may be dealt with, and from which a choice can be made of those most appropriate to a particular situation. The different types of control measures can be clearly illustrated by using, as an example, the conception suggested by Gibson (1961), that "injuries to a living organism can be produced only by some energy interchange". This concept was elaborated and extended by Haddon (1966, 1973) indicating that injury production was by the "delivery to the body of energy in excess of local or whole body injury thresholds" and "due to interference with normal or whole body energy exchange". He suggested a succession of counter measures in order of priority, one or more of which may be used to deal with the harmful effects of energy transfer. They are:

(1) limit the energy;
(2) substitute a safer energy form;
(3) prevent the build up;
(4) prevent the release;
(5) provide a slow release;
(6) channel the release away; ie. separate it in time or space;
(7) put a barrier on the energy source;
(8) put a barrier between the energy source and the persons or objects protected;
(9) put a barrier on the person or object;
(10) raise the injury or damage threshold;
(11) ameliorate effects;
(12) rehabilitate.

Every method adopted to deal with accidents which may occur in a construction site could be classified into one of these categories.

4.6 Safety Performance

Safety in the industrial context is meaningful only if it is seen in the terms of economic, behavioural, social, legal philosophical, procedural and technological aspects relevant to the particular industry. The development of safety measures that are compatible with these other issues is essential to ensure their adoption in site conditions. The problem of improving the safety level of an undertaking is much more complex than simply ensuring that the causal factors and hazard control measures are widely known amongst personnel. The popular emphasis on creating awareness of safety measures seems to be based on the simple notion that if control measures are available for a particular hazard, only ignorance will limit their use. Reality however, seems far from this uncomplicated idea. Organisations and individuals have many objectives other than safety, the interaction of which has a marked influence upon whether safety measures are adopted or not.

4.6.1 <u>Safety Performance at the Organisational Level</u>

At the organisational level, some of these other objectives, such as the achievement of production, quality, cost and other targets can conflict with the adoption of safety measures. Trade-off between the degree to which different objectives are achieved in the presence of conflict, is a universally accepted and known phenomenon. The sacrifice of quality for the purpose of reducing cost is the most common. Similarly, safety in an organisation can suffer, when other objectives receive a higher priority. The choice of goals in different sections of a construction site at any one time is complex. Many factors that can influence the site from within and without were discussed in Chapter 2. The goals, which can either be short term or long term may also change with time. Therefore, the goals set for the supervisory section at any particular time, exercise a powerful influence upon its safety performance. These goals manifest themselves in the form of the work climate, in which individuals perform their respective functions.

The physical environment in an organisation which directly affects the safety performance of individuals working in it, is an optimisation of a variety of objectives pertaining to each component of that environment. For example, the layout of a construction site should acommodate the production needs such as storage, transport and handling operations, and other construction activities within a limited space, so as to optimally achieve the production, cost, time, safety etc. objectives. Since it is unlikely that all these could be met simultaneously, invariably a compromise has to be made. The physical environment consists of a large number of factors, which affect the safety performance of the organisation (Surry 1969). The nature of the equipment, material, atmospheric and weather conditions, light, noise and heat are just a few examples. The degree to which this environment is arranged to achieve a high level of safety performance is dependent upon the degree of organisational priority and effort allocated to safety.

A variety of factors in the 'social climate' of the work place has also been found to be related to the accident rate in organisations. Many studies have shown that accident rates increased with rapid changes in the work force (Stresan 1961) with increased rate of production and with other disturbances related to the social stability of the work

(Farmer et al 1933, Littauer 1956). Worker discontent and "negative" attitudes have been found to be related to increased accident rates (Thomae 1963, Davids and Mahoney 1957). On the other hand, good employee-management and good morale have been found to be related to low accident rate (Keenan et al 1951).

4.6.2 Safety Performance at the Individual Level

In addition to the influence of the physical environment and social climate factors discussed above, safety performance of people at work is also influenced by a large variety of personal factors. Hale and Hale (1972) in a review of the industrial accident literature, and Surry (1969) discussed in detail the functions and limitations of the senses, central nervous system and motor activity in observing, recognising and taking suitable action to avert danger. All these personal factors determine the ability of the individual to cope with a situation without it resulting in an accident. If the situational demands exceed this ability it is postulated that accidents will happen. A compromise between the assets and liabilities of work personnel and the environmental and performance demands of the work place is therefore an essential aspect of safety.

The goals of individual people at work are also influenced by a large variety of factors other than the goals of the organisation. Many personal and social circumstances combine with emotional and subconscious aims to contribute towards the goals of an individual. Some of these goals eg. speed and accuracy can be conflicting. Different goals will also have different priorities at different times. There is a substantive body of literature available on decision theory, dealing with the process of compromising goal achievement and factors concerning risk taking of individuals, for example,Cohen (1960) and Weil (1966). People are known to take risks for a variety of reasons. In certain hazardous situations people see more disadvantages than advantages in the safety option. This is known to be particularly true, in cases where some incentive exists in favour of not taking safety precautions and the chance of immediate or significant harm do not appear to be great. Grimaldi (1970) stated:

> "Risk vs gain trade-offs seem to be assessed instinctively (but sometimes analytically) according to such criteria as: the threat to the mission, the probability of a harmful consequence, the degree of physical loss and suffering which could occur, as well as the sensitivity of legal and ethical relationships inherent to the venture and which are balanced more or less against the rewards expected from taking the risk."

It therefore seems that safety vs risk assessment by individuals is a crucial factor that influences safety performance in an organisation. Hale and Perusse (1977),in surveying attitudes to safety, concluded that "people are not very good at looking after their own safety in the sort of situations that exist in most industries".

It is clear from the above, that to know the personal approach of an individual to safety, under the specific circumstances in which he is found at any particular time, is a vital factor in understanding his behaviour on that occasion. A study into the safety behaviour of the construction supervisor therefore, is best conducted on the site under his usual working conditions.

4.7 Central Approaches to Safety

With the rapid development of technology and the move towards state control of technological hazards, it has been found necessary to adopt a variety of approaches to safeguard the work force from the hazards of work. Atherley (1975) discussed the strategies that are currently being used in connection with the arrangements of health and safety at work. He classified them into the following three classes:

1) Pre-accident strategies comprising safe place and safe person strategies;
2) Post-accident strategies comprising contingency, ameliorative and feed-back strategies;
3) Collateral strategies which are relevant to health and safety but whose principal objectives are only remotely concerned with preventing or coping with accidents or not at all.

The use of these strategies in a systematic and efficient manner on the basis of detailed information and analysis of the hazards to arrive at optimum solutions is a continuous process. This process has to be based on a fluid set of values and an advancing level of knowledge and needs to be carried out from a well informed vantage position. The central approaches to their practical implementation include registration and licencing, regulatory control, application of standards, education and training, monitoring and maintaining surveillance etc. Responsibilities for safeguards are also divided amongst individuals, organisations which employ them, other relevant undertakings, governments etc. . .. However, the extent of protection that can be provided by regulations and standards is limited, for a number of reasons. The need for feasibility of enforcement, limitations of resources that can be allocated for enforcement and the changing nature of what is reasonable and what is practicable are just a few examples of issues affected by the social, technical, political, economical, judicial etc. questions involved. In the case of construction, in view of the enormous variety of activities, and the number of ways in which they can interact and thereby influence safety, it may not be possible to lay down safety standards for every conceivable situation. In a survey carried out by H.M. Factory Inspectorate (Great Britain: Ministry of Labour 1967), where 140 construction sites were kept under surveillance for six months, a number of useful observations were made. Of the 270 reportable accidents which occurred on these sites during the period 1st January to 30th June 1966 only 19% could be regarded as clear breaches of the regulations. Figures were not available on the non-reportable accidents. However, the 81% of the reportable accidents which did not involve breaches of the regulations (it may have been possible to specify regulations for some of them), indicate to some degree the extent of activities against which regulation by standards may not be practicable. This figure is comparable with the results of a study of 0.5% random sample of accidents (other than those in construction sites) notified to the H.M. Factory Inspectorate during the period 1st July to 31st December 1968 (Great Britain: Department of Employment 1974). There were breaches of the law only in about 18% of the accidents. It appeared, in the opinion of the investigators, that only 50% could have been prevented by reasonably practicable precautions. This however, does not undermine the value of the regulations, because their presence could have prevented a large number of accidents which obviously do not appear in the statistics. Although similar studies after 1974 are not yet available, since the precautions stipulated under the Health and Safety at Work Act 1974 are, in the vast majority of industrial situations, subject to the condition of reasonably practicableness, and the construction regulations are still the same as those under the Factories Act of 1961, it is likely that a high proportion of accidents could still happen in conditions where there are no breaches of the law, and certainly when no specific regulations are broken.

As discussed in Chapters 2 and 3, the jobs of most construction personnel, their tasks and detailed behaviour are not specified. The individual's performance is defined and judged by the jobs he completes rather than by the way he does them. The immediate work surroundings and the methods and techniques of working are often under the control of the individual workman himself. Even if standards were specified for purposes of regulation, in the case of most activities in construction, observance of the majority of them would depend upon the operative.

In view of the nature and characteristics of the industry it is questionable whether it is practicable to get all construction personnel familiar with the standards pertaining to the full range of their activities. The variety of factors limiting the extent to which construction operations could be influenced by imposing responsibilities and regulations because of the organismic nature of the organisation were also discussed in the previous chapters. The value and importance of regulations and safety standards is not under dispute here. This is not an attempt to criticise such standards but rather to recognise the limitations of the extent to which they can influence the level of safety on sites. A basis for appraising safety on a site, which does not depend solely on the regulations and standards but in addition includes other important characteristics, needs to be developed.

4.8 Assessment of Safety

Developing techniques for studying safety meets with the same range of problems as developing methods for studying good health. Definitions such as the one of the World Health Organisation that "health is a state of physical, psychological and social well-being" have not been made operational in practice. The state of health is judged on the basis of the degree of health disorders such as disease, illness and disability. Similarly safety is described and measured as the lack of physical harm. The simplest dictionary definitions of safety, such as "freedom from risk", "out of, not involving or not exposed to danger", "immunity from harm", "freedom from hazard", etc. are not useful for the practical purposes of a study because of the ambiguity of their meaning. They imply absolute, unconditional or ideal situations that do not in fact exist. However, it is a truism that there is hardly any human activity which under some circumstances may not cause harm. Therefore nothing can be said to be absolutely free of risk, danger or hazard ie. nothing can be said to be absolutely safe. Different situations have different degrees of risk and hence different degrees of safety. Atherley (1975) in discussing "Strategies in health and safety at work" used the definition:

> "For present purposes, safety is taken to refer to level of risk of accident and certain kinds of disease where the level of risk is considered acceptable".

The diseases he referred to "are those which are aetiologically linked with occupation, or environment in certain contexts". The concept of "acceptable risk" is now being widely used in the discussions concerning safety. For example, Lawrance (1976) examined the interpretation of this concept with regard to a number of public issues. The use of the term "acceptable" gives rise to many further questions such as "acceptable to whom?", "acceptable for whom?" and "acceptable under what circumstances?" What is acceptable to different people can be widely different, and the knowledge of hazards and risks also changes. The standards of acceptability, whether personal or social therefore change with time, vary with the context, and above all, depend upon who is making the judgment. The provision of restraints in the form of regulations, codes and standards is a result of society's recognition that it is not proper to require or depend on the individual to make value judgements concerning certain risks. The provisions are the results of a consensus of prevailing expert opinion, which give added protection. Atherley and McGinty (1977) discussed the problems of quantifying risks and of reaching a consensus as to what level of risk is acceptable, and the inadequacy of the methods presently adopted to reach it. They suggested that such quantifications could not be considered as an end, but merely a guidance to the minimum level of safety in those particular cases, providing a

valuable aid for individual decisions.
In view of the above, it is clear that the concept of safety is relative, judgemental, and extremely complex. As pointed out by Lawrance (1976), although there are methods to assess probabilities and consequences of events, it is not possible to evaluate their value to people. One cannot therefore expect to measure safety accurately at the operating system level. Apart from the shortcomings of the statistical measures of accident rates, discussed by Shipp and Sutton (1972) and the Robens Committee Report (1972), such measures are retrospective. Because of the inherent characteristics of continuous change in construction workplaces, unlike more stable organisations, such after the event safety performance measures have little relevance to an ongoing site. Any assessment of the safety of a specific workplace has to be made in terms of its own particular characteristics so that it applies to the conditions as they are, without waiting for accidents to happen. Since this study is concerned with safety at the operating system level, the details of past accidents are relevant to identify accident producing characteristics of construction situations (development of expertise) rather than to quantify an assessment of the safety level. It would then be more realistic and feasible to base the study of a particular site on diagnosing and investigating the accident producing symptoms present in it. Such a diagnostic approach was considered most appropriate for this study.

4.9 A Diagnostic Approach

Any process of diagnosis will be made easier, if the total complex situation is divided into simpler components for detailed examination. Construction operations can be viewed as being carried out in a certain work setting (the physical locale in wich work takes place), by a set of personnel (people who are engaged in the activities), using certain provisions (the plant, equipment, materials etc.) according to certain systems of work (the procedures and practices followed). These basic components of a construction workplace can be described as follows.

Work setting - This refers to the objective physical setting in which the work behaviour takes place. It consists of the outside boundaries of the site, the inside boundaries separating it into different sections, site premises, and the location and arrangement of both the inanimate physical objects and personnel within it. Construction operations will be facilitated by some characteristics of the work setting and hindered by others. The worksetting determines, to a large extent, the nature of the personnel and provisions employed, and the systems of work adopted. A construction site is a transitional worksetting (ie. a physical locale in which work takes place that is temporary in structure and permanent in location) that is being continually altered from the beginning to the end of the project.

Personnel - This relates to the 'quality' and 'quantity' of persons engaged in the site activities. Persons are actors within the setting. Their behaviour influences the resulting dynamics of the situation. They have the ability to influence, and they often determine the ways in which settings and provisions will be maintained and used and what systems will be adopted. Persons' actions are based on their selective perception of the surrounding milieu, interpretations, attitudes, beliefs, abilities, expectations, motivations etc..

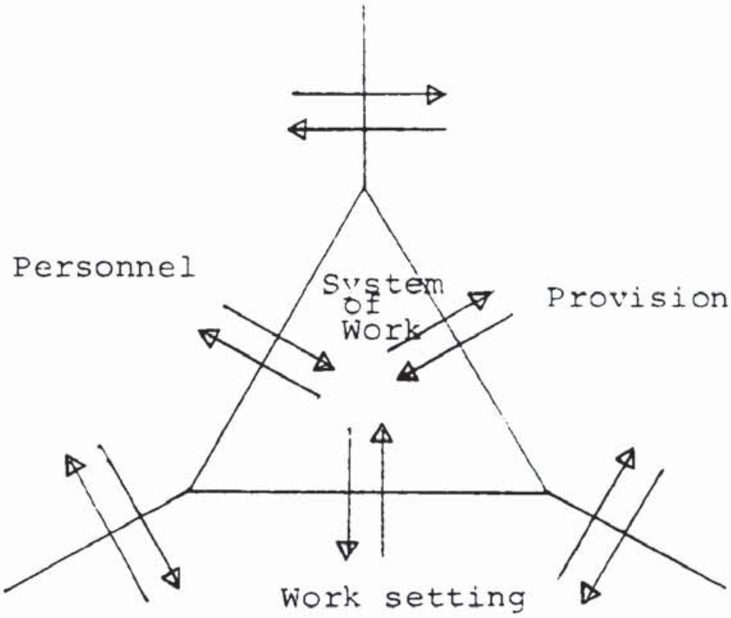
Provisions - This refers to the inanimate objects made available for the conduct of the site activities, eg. plant, machinery, equipment, tools, materials etc.. Here, they are seen primarily in the context of 'quality' and 'quantity'. Provisions facilitate certain operations while restricting others. The worksetting, personnel and systems of work depend to a large extent upon the provisions that are being used.

System of Work - refers to the process, location, sequencing and arrangement of activities ie. the procedures and rules adopted in their execution. It is the organisation of the nature and location of activity within the co-ordinates of time and space. It is the system followed by the dynamics of the construction activities, and involves the progress of interaction between worksetting personnel and provision components.

These four interdependent components interact continuously. The total situation can be altered or controlled within limits by changing any one of them. Their interdependence and dynamic interaction may be diagramatically represented by (Fig 1)

FIG 1

Interdependence and Dynamic Interaction Between Situational Components



The workplace is a compromise between the assets and liabilities of these components. Deficiencies or irregularities can be compensated for by improvements and modifications in one or more of them.

For example, the engagement of personnel with specified ability, competence, training etc;

the use of specified provisions such as special types of equipment, material, personal protection, etc;

special modifications to the settings, such as improved ventilation, erection of barriers, and supports etc.

and adoption of special systems of work, such as permit to work systems, periodic examinations, specified procedures for storing, handling and the use of dangerous substances etc.

In view of the interdependence of the components and the fact that they can be modified if necessary, the safety of a construction workplace can be said to be judged by the safety adequacy of the components to meet the demands of a particular situation.

Checking the individual components for shortcomings is the common technique adopted to diagnose irregularities in highly complex systems, for example, doctors checking the health of a human being by testing different parts of the body; mechanical engineers testing different parts of an engine; electrical engineers testing the components of an electrical system etc. Similarly, it is suggested that the safety of a site can be studied by checking its basic components for their adequacy in relation to the specific situation. In the dynamics of the workplace, maintaining safety is a question of ensuring continuous safety adequacy of each component under changing circumstances.

The safety role of a construction supervisor can therefore be described as the role he plays in maintaining the safety adequacy of the work setting, personnel, provisions, and system of work components, during the progress of site work. A study of this role will, in addition to diagnosing shortfalls in the safety of these components, require an investigation of the ways in which supervisors perceive and evaluate them.

4.10 Summary and Conclusions

Risks are an inherent feature of every human activity. Different industries have risks peculiar to them. Attempts to study and deal with safety problems in the construction industry by systematic methods started only in the recent past. They are bound to require changes in the way the industry has been functioning.

Data on past accidents have been made use of in developing the vast majority of present day safety measures. They have served two purposes:

(a) as a safety performance measure

(b) as a basis for expertise, to develop measures to control the risk and limit the consequences of future accidents

Safety activities in industry are primarily based on a 'causal' model. The type of 'causes' considered in a study depend upon the frame of reference and the concepts chosen. Since supervisory functions are carried out at the operation system level of an undertaking, causal factors (ie. factors which increase the chance of an accident) at this level only were considered important for this study.

Safety measures need to be compatible with many other important issues facing construction organisations.

Arriving at optimum solutions to safety problems in a site is a continuous process made on a fluid set of values and an advancing level of knowledge.

Organisations as well as individuals have many objectives other than safety. Trade-offs between safety and those other objectives is a common phenomenon. The large number of factors which influence the approach adopted by organisations and individuals towards safety depend upon the circumstances of specific cases.

There are limitations to the extent to which safety in construction sites could be achieved by standards and regulations. This study therefore cannot be limited solely to those.

The concept of safety is relative, judgemental and complex. One cannot expect to measure the safety of an ongoing construction workplace. Diagnosing and investigating the safety inadequacies of the worksetting, personnel, provision and system of work components of a construction situation is far more feasible.

The safety role of a construction supervisor is the role he plays in maintaining the safety adequacy of these basic components. A study of the ways in which supervisors perceive and evaluate these will enable one to gain a clear insight into this role.

CHAPTER 5

METHODOLOGY

5.1 Choice of Techniques

There are two approaches to the choice of techniques and procedures for any systematic investigation. One is to start with the problems and then search for suitable methods. The other is to be armed with the methods first and then look for circumstances where they can be used to investigate suitable problems. The former is termed a 'heuristic' approach and the latter, an 'instrumental' approach (Hamblin 1974). In an exploratory study such as the present study flexible heuristic techniques which could be adaptable to a wide variety of situations were considered more suitable than rigid techniques applicable to controlled experimental situations. Because of the scarcity of knowledge as to which are the relevant variables, a controlled study carried the danger of excluding factors which might be important. It was therefore decided that the technique for this study should be based on a descriptive, discovery design, rather than an experimental design.

Distinction also can be made between techniques which are used to study the entire job behaviour of supervisors and those which aim to study only certain aspects of their job. The former would adopt a unidimensional approach and provide a global appraisal in terms of the overall effectiveness. Some techniques adopted for this purpose are, ranking of sub-ordinates'overall performance by their superiors (Mahoney et al 1960,Argyle 1957), global self-appraisal (Pym and Auld 1965), and activity sampling (Pinschof 1964, Kelly 1964). Although the vast majority of supervisory studies in the literature have adopted a uni-dimensional approach, job performance seems to be really multi-dimensional as discussed by Ghiselli (1956). This means that different criteria should be used to study different aspects of job performance. This study, being concerned with the safety role of the supervisor, uses criteria of safety performance rather than those of overall performance.

One method of defining a work role is by investigating the content of an existing job, and the knowledge, skills and attitudes of those who perform it. Examples of this approach are skills analysis. (Seymour 1968,Singer and Ramsden 1969) and task analysis (Annett and Duncan 1970). Such methods are commonly adopted and are most suitable for manual operations, where a number of people do identical jobs, the jobs do not change frequently over time, are separate from one another, and are easily observed and analysed for the purpose of setting behavioural objectives. However, as discussed in Chapter 3, supervisory jobs in the construction industry have been found to be discretionary in nature, largely unique, and subject to fast changes, thus making the above approach inappropriate. The behavioural objectives in this case need to be defined on an individual basis and cannot be presented in the form of a job description.

Many studies on supervisory training, (Meade and Greig 1965, Warr and Bird 1967,Jones 1968) have been in favour of a problem-centred approach, in which the investigation of the job behaviour is concerned not with the job, or a particular aspect of the job as a whole, but only with specific problem areas. Analysis is limited to the areas where an improvement is found to be desirable. This approach is particularly suitable for setting objectives for the safety performance of construction supervisors. This can be done by concentrating on safety inadequacies of situational components as discussed in Chapter 4 which would represent safety problem areas.

The Critical Incident Technique originated by Flanagan (1949, 1954) is also concerned with identifying, analysing and interpreting only incidents critical to the problem of study, which are then converted into objectives for various types of improvement programmes such as training, selection, re-organisation etc. Flanagan defined the term 'critical' as meaning 'making the difference between success and failure'. This technique has been developed and used in many studies (Campbell et al 1970, Randell and Still 1973).

However, these studies have been highly technique-oriented. Glickman and Vallance (1958) used the descriptions of critical incidents directly for setting behavioural training objectives, rather than as indices of behavioural dimensions. This facilitates the use of the technique on the basis of individually relevant criteria, and enables it to be responsive to a variety of specific situations. Such a method was considered to be appropriate for a study of the safety role of the construction supervisor, wherein, safety inadequacies in the situational components could be treated as critical incidents representing safety performance objectives.

5.2 Analysis of Social Situations

Human behaviour takes place within a situational context. Thomas (1931), stated "If men define.......situations as real, they are real in their consequences". He argued that it is the individual's interpretation of the social situation confronting him, that is the most fruitful to study for an understanding of human social behaviour. He conceived of a social situation as "the set of values and attitudes with which the individual or the group has to deal in a process of activity and with regard to which this activity is planned and its results appreciated".

Stebbins (1967) distinguishes between "objective" and "subjective" situations. He defines the objective situation as

> "the immediate social and physical surroundings and the current physiological and psychological state of the actor".

The subjective situation is defined as

> "those components of the objective situation which are seen by the actor to affect any one of his action orientations and therefore must be given meaning before he can act".

The subjective interpretations that persons make concerning the situations in which they find themselves can be influenced in two different ways. These are interrelated. First, persons are seen to filter out, through perception and interpretation, certain objective elements and to act in terms of these after a stage of examination and deliberation during which they also employ their pre-existing attitudes and past situational experiences (Thomas1931). The second perspective is the cultural orientation whereby persons are seen to have learned and internalised, through a process of 'socialisation', the appropriate and not so appropriate ways of doing things.

The objective and subjective elements are an important division in the analysis of social situations. Although they are strongly linked, viewing the objective situation "as the

total collection of situation elements and their inter-relationships", provides a set of observable elements out of which persons can be seen to select out their interpretation of the situation at hand. This forms an appropriate basis upon which a model may be based for investigation of a construction supervisory situation.
Supervisory behaviour is seen to be the result of the way in which the supervisor, perceives and interprets the surrounding milieu, his attitudes and beliefs, and his own expectations and those of others concerned. The influence of both objective and subjective elements is equally important. An understanding of how supervisors perceive and interpret the large number of variables concerning critical elements relating to safety, and their interaction was therefore considered essential for evaluating their safety role. In other words, the details of the situation as seen by the supervisors themselves needed to be identified.

5.3 Observer Bias

Any investigation of job behaviour is confronted with the problems of two forms of observer bias. One is due to those under investigation acting differently because they are being investigated. The other is misinterpretation of the data by the investigator. The method of study needs to be designed so as to minimise both these effects. Obtaining the co-operation of personnel under investigation, to the extent where they will willingly provide accurate data about their own behaviour, is crucial. It is virtually impossible for an investigator to interpret behaviour completely and accurately by merely assimilating the observable facts about the situation and that behaviour. The observer's understanding of the situation is restricted resulting in what Riley (1963) calls the biased viewpoint effect. Also, behaviour is based, not on the reasoning of the investigator, but on that of the person who is being observed. Unless the subjective interpretation of the objective facts by the latter is included in the investigation, it can result in inaccurate conclusions. being drawn. The use of the supervisors themselves as the main source of information about their behaviour and the reasons for that behaviour, was therefore considered the most suitable approach for the present study.

5.4 Practical Limitations on Methodology

Considering the extremely complex nature of the construction industry, it was vital that the technique chosen for collecting the data suited the purpose and practical circumstances encountered. It was also crucial that the technique was one that was acceptable to the supervisors, because their wholehearted co-operation was essential for its successful application.

As mentioned in Chapters 2 and 3, construction supervision is mainly a field job. It is generally concerned with the practical site activitiesof construction. A majority of the supervisors have experience of many years of working in the industry dealing with practical field operations rather than office work. They often work under very high pressure and do not react favourably to their work being interrupted. The research technique therefore, had to be one that would least disturb their normal routine of work. The practical difficulties of getting such field oriented persons to to fill-out forms in response to questionnaires were considered to be insuperable. Moreover, because of the large number of factors and variables which form a construction situation, more detailed and accurate responses were likely to be obtained by seeking information on the existing works rather than hypothetical or bygone situations, a view supported by Bayley (1967). It was also seen in Chapters 3 and 4 that the detailed information most suited to this research was that concerning the ongoing supervisory section. Therefore the technique chosen had to gather information on the supervisor's own work milieu and involve minimal distrubance to his normal routine. The following section describes the method adopted in the light of the discussion above and in the preceding chapters.

5.5 The Method Used in the Present Research

The overall method adopted in this study consisted of three parts. In the first, a framework was derived for the purpose of identifying critical elements (ie. safety inadequacies) in a supervisory section. This was done by studying descriptions of situational characteristics which had been identified by the respective site personnel as factors contributing to previous accidents on sites. A list of descriptions of safety inadequacies, termed 'accident symptoms' was the final outcome of this part of the study.

Since the accidents used in this part of the study were not a relevant measure of safety performance (see section 4.8) no attempt was made to compare the safety performance of the sites using accidents. The accident symptoms were to be used as stimuli for the second part.

In the second part of the method, the list of accident symptoms was used to identify the safety inadequacies in the sites visited and to generate information from the supervisors themselves about the factors influencing their interpretation and evaluation of those inadequacies, in the context of the particular situation.

Although it would be possible to use the number of accident symptom occurrences present in a supervisory section as a measure of its safety, in view of the wide variations in size, activities, materials, equipment, etc. between supervisory sections and the fact that the entire supervisory section could not be covered in all the visits, such a measure was not used in this study for purposes of comparison between supervisors. Such a comparison of overall performance was not in any case the purpose of the study. Instead, the percentage of accident symptom occurrences falling into a particular category was used as the basis for analysis of the factors affecting supervisory perceptions.

This part of the study highlighted the perception by the supervisors, of a number of factors as influencing their safety role. These factors were related either to safety role problems or to the ways in which supervisors coped with those problems. However, the investigations had to be limited to the perceptions of the supervisors alone. It was not possible to check the degree of agreement between the perceptions of the supervisor and those of the other role incumbents in the organization. This was because of the need to safeguard the confidentiality that had to be guaranteed to the supervisors in order to collect information from them, and because of the practical difficulty of gaining the very high degree of co-operation and involvement needed from a sufficiently large number of firms. The third part of the study was designed to examine this question of concurrence using a limited number of sites.

Part 3 of the study consisted of detailed case studies on 4 supervisors in 3 construction sites, using the list of accident symptoms together with the factors highlighted in part 2. In these studies, in addition to the supervisor, his superiors as well as the safety officer were interviewed to examine the implications of their perceptions. This part of the study also provided a practical test of the method within the limits of the small number of sites studied.

5.5.1 <u>Criteria for Identifying Safety Inadequacies on Sites</u>
Classification of construction accidents used commonly in the industry (see appendix 1) do not allow information that is useful for control purposes to be extracted. The accidents are normally under the headings of how the injuries happened or what caused the injuries, for example, falls of materials, falls of persons, striking against etc. and general descriptions such as hand tools, electricity etc. It is not possible to relate these directly to the conditions of an ongoing site without considerably more detail. Hence accident statistics cannot be used as a basis for identifying safety inadequacies. In order to gather the further details necessary, it was decided to look at actual accident descriptions, gleaned from reports made at the time of the accident. The purpose of identifying safety inadequacies in the sites was to use them as stimuli to elicit information from the supervisors. The criteria used therefore had to be meaningful to them. Characteristics of the situational components, worksetting, personnel, provision and system which were stated by the site personnel as causal factors contributing to the accidents in construction accident reports were collected. These were considered to be clear and sufficiently meaningful to the supervisors to be used as the basis of field interviews because they were ones which had been generated by people like themselves.

A total of 705 reports of accidents in 116 sites belonging to 28 different construction firms were studied in detail. The details of this breakdown are given in Chapter 6. Causal factors cited in connection with the accidents and their consequences were analysed.

These factors were then categorised and expressed in the form of general descriptions of component characteristics so as to form a list that was applicable to any construction situation. Such characteristics were termed 'accident symptoms'. A distinction needs to be made between the common concepts of 'danger', 'hazard', 'risk' and the concept of 'accident symptom'. The term accident symptom includes, in addition to hazards, failure to comply with control measures which may not manifest themselves as hazards to supervisors, for example, failures to periodically inspect and examine plant equipment etc., even though there are no apparent faults.

Lists of accident symptoms were formed under each component heading. A detailed description of the accident symptoms and their derivation is given in Chapter 6. The main purpose of the accident symptom lists was to provide a working tool to guide the site investigations. They were to provide a comprehensive framework and an orderly system, for scanning the site to identify safety inadequacies. It was expected that such a framework would help to avoid the tunnel vision due to personal bias of the observer. The lists were considered a relevant, clear and direct check-list pin-pointing safety shortfalls on sites, which could be used as a basis for the site investigations forming the second part of the study.

5.5.2 The Field Study

Gold (1958) distinguished between four research roles in sociological field observation.

1) Complete Observer - Here the observer does not interact to a large extent with his subjects. He rather locates

himself at the periphery of a social setting in order to gather information.

2) Complete Participant - Here the researcher conceals his scientific intents from his subjects and attempts to become a fully-fledged member of the group he is investigating.

3) Observer as Participant - Here the researcher is not concerned with establishing an enduring relationship with those he is studying. The contact is formal and brief and can best be characterised by a researcher conducting a formalised interview or administering a questionnarie. These are typically one-off events.

4) Participant as Observer - Here the investigator participates as a member of the group he is studying. He makes his presence known and attempts to establish relationships with his subjects. The investigator's role as researcher may or may not be concealed from his subjects.

In view of the nature of the field of study, the problem under investigation, and the background of the researcher, it was decided that the most suitable technique for this research would incorporate a role closest to the third above, namely "observer as participant". As pointed out by Becker (1958) participant observation is most suitable for exploring a new field for the purpose of identification, definition and description of problems, concepts and indices. It has the merit of providing a means of studying a whole system with its many interrelationships in great detail. However, observation alone is inappropriate for studying opinions and attitudes of people. The interview is the most appropriate method for this purpose. In order to avoid distortions of the data by either observation or interviewing (Moser and Kalton 1971), both these methods were used in the present study to ensure the greatest accuracy and least bias and to provide corrobative evidence for each other.

Tacey (1960) in using the critical incident technique to study the communication behaviour of industrial foremen found that, of the three techniques (interviews, diaries and questionnaires) used, satisfactory returns were achieved only through the interview method. The choice of the interview method in this study was also necessitated by the fact that, careful explanation of the purpose and the meaning of the concept of accident symptoms and related questions was essential.

Cannel and Kahn (1968) distinguished three broad important concepts for a successful interview

(a) Accessibility of the required information to the respondent.

(b) Cognition or understanding by the respondent of what is required of him.

(c) Motivation on the part of the respondent to answer the questions accurately.

In view of the flexibility desirable for this study and its contextual nature, a formal and completely structured interview was considered unsuitable. The focussed or guided interview seemed more appropriate (Fiske et al 1956,Gordon 1969). It allowed the respondent more freedom, while still covering a given area in a systematic way. It was flexible, unlike the formal methods, and covered topics according to a set framework, still giving the respondents the opportunity to develop their views in detail as well as allowing the interviewer to frame the questions in a way appropriate to the particular situation. This was vital in a study using accident symptom occurrences which were bound to differ from site to site, as the basis for the questioning.

As discussed in Chapter 3, the supervisory work situation in a construction site consists of a highly complex network of interrelated factors. The field investigations in Part 2 of the study was therefore aimed at investigating how supervisors perceived and evaluated accident symptoms in the context of a particular work situation. The criteria that supervisors use in this evaluation are dependent upon the factors that they take into account and the relative importance accorded to them. The factors relating to the supervisor's immediate environment and those of the organisation having an influence upon his perception and evaluation were also considered to be of considerable importance. As pointed out in Chapter 2, this large range of factors change frequently in a construction workplace. As Stogdill et al (1956) found in a study of executive behaviour, managers constantly revise their evaluation of the importance of events in the light of subsequent developments. In view of this constant change and re-evaluation it was considered more fruitful and simpler to study the criteria used by supervisors for their decisions and behaviour than the behaviour itself, since the former effectively determine what role the supervisors play. The site investigation technique was designed to elicit this information.

In view of the scarcity of knowledge in the area, a list of factors which had been identified as influencing the safety role of the supervisor was not available at the Part 2 stage of the study to be given to the subjects for sifting or grading. Also, if the investigation was limited to such a list, there was the danger that some really important factors outside that list might be excluded. Therefore, in order to accommodate variables from all aspects and to ensure that none was excluded, it was decided that the subjects should generate that information themselves. However, this would result in gathering information at random on a wide variety of influences. In order to simplify the task of recording the data in a systematic form, a simple framework, or model had to be devised, into which information could be grouped as it was generated. The development of such a model is discussed in the next sub-section. In part 3 of the study it was possible for the interviews of the supervisor to be guided by the factors identified in Part 2 and the interviews of his superiors to be guided by the information generated from the supervisory interviews.

5.5.3 The Development of a Model for Data Collection

There are many models of the decision making process in relation to accident prevention. Surry (1969) discussed these and proposed a model which included many concepts of previous models and had three principal stages with two similar cycles linking them (Figure 2). She differentiated between the actions necessary for the prevention of the build-up of danger and those for the release of danger. She pictured danger as growing up from the total environment consisting of tasks, equipment, personnel, etc. which is being constantly changed by man and nature. This is the build-up cycle. The second cycle covers the avoidance of injury during the danger release stage.

The first cycle can take a long time, whereas the second is

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Fig 2 A Decision Model of the Accident Process (Surry 1969) often very short and sudden. Since supervisors are concerned with the safety of a workplace and its occupants rather than avoidance of personal accidents to themselves, they are primarily concerned with the danger build-up cycle rather than the injury avoidance cycle. The three stages in Surry's build-up cycle, once a warning of danger build-up appears are perception (ie. perception of warning), the cognitive process (consisting of recognition of warning, recognition of avoidance mode, and decision to attempt to avoid) and physiological response (ability to avoid). Such a model is not directly applicable to the decision making process of a supervisor. This is because Surry's model refers to the decision and action processes of an individual towards danger to himself, whereas a supervisor's decision and evaluation processes are concerned primarily with danger to others.

It was therefore found necessary to develop a model that is appropriate to the circumstances of a construction supervisor. Using an accident symptom occurrence in the workplace as a warning of danger, the model for data collection in this research was constructed on the basis of the following rationale.

1) The ability of the supervisor to recognise accident symptoms was considered to be of primary importance, since without recognition no action on his part could take place. The reasons for failure to recognise would highlight the factors which influence this process.
2) In the case of accident symptoms, which the supervisor did not recognise on his own, it was considered very important that he accepted or did not reject those pointed out by someone else, (eg. the safety officer) because the supervisory actions necessary and/or the supervisory support for actions by others

depended upon this. The reasons for rejecting any accident symptoms were considered important as guides to the perception of danger.

3) In the case of those accident symptoms that the supervisor recognised or accepted when pointed out, the next problem was whether he would take steps to deal with them. This depended upon whether he thought that he ought to do so. If he did not, in any particular case, the reasons were regarded to be of major interest to this research.

4) In the case of those accident symptoms that a supervisor did not think he should deal with, it was crucial to know if he thought that anybody else should deal with them since if he did not, he would not support or perhaps even would discourage actions by others to deal with them. If he thought that nobody should deal with certain accident symptoms, the reasons behind it also would be of interest.

5) Whether or not the supervisor knew a suitable method of dealing with an accident symptom was a question that had to be included in the model, because otherwise his action, if any, would not be effective.

6) Finally in order not to lose any crucial information, the supervisor was invited to give any further reasons, that he felt were important to explain the existence of the accident symptom on that occasion.

The model thus developed, on the basis of which interviews were carried out on a step by step basis is presented in the form of a flowchart (Fig 3) accompanied by the legend on page 128. This model was used to bring order into the field study by the following procedures:

i. it simplified recording the interview data where the information could be grouped into the relevant category as it was recorded;

ii. it provided guidance in selecting from the mass of information generated, what was relevant;

iii. it formed the basis for the later discussion of results

Part 3 of the study used the same model to generate relevant information from the supervisor with one modification. Instead of inviting the reasons for NO answers to questions in the elements 1, 1.2, 2, 2.2, 3 and 3.2, the supervisor was given, in each case, the possible influencing factors as found by part 2 of the study, and requested to indicate which of those were the reasons on that occasion. The aim of this modification was to ensure that all the possible influences were investigated in the detailed study. The subsequent interviews of the supervisor's superiors and the Safety Officer were then conducted to examine the degree to which their perceptions were concurrent with those of the supervisor.

5.6 The Study Sample

In view of the extensive variation found between different supervisors and supervisory situations in the construction industry, (discussed in Chapters 2, 3 and 4) it was not possible to select a statistically representative sample

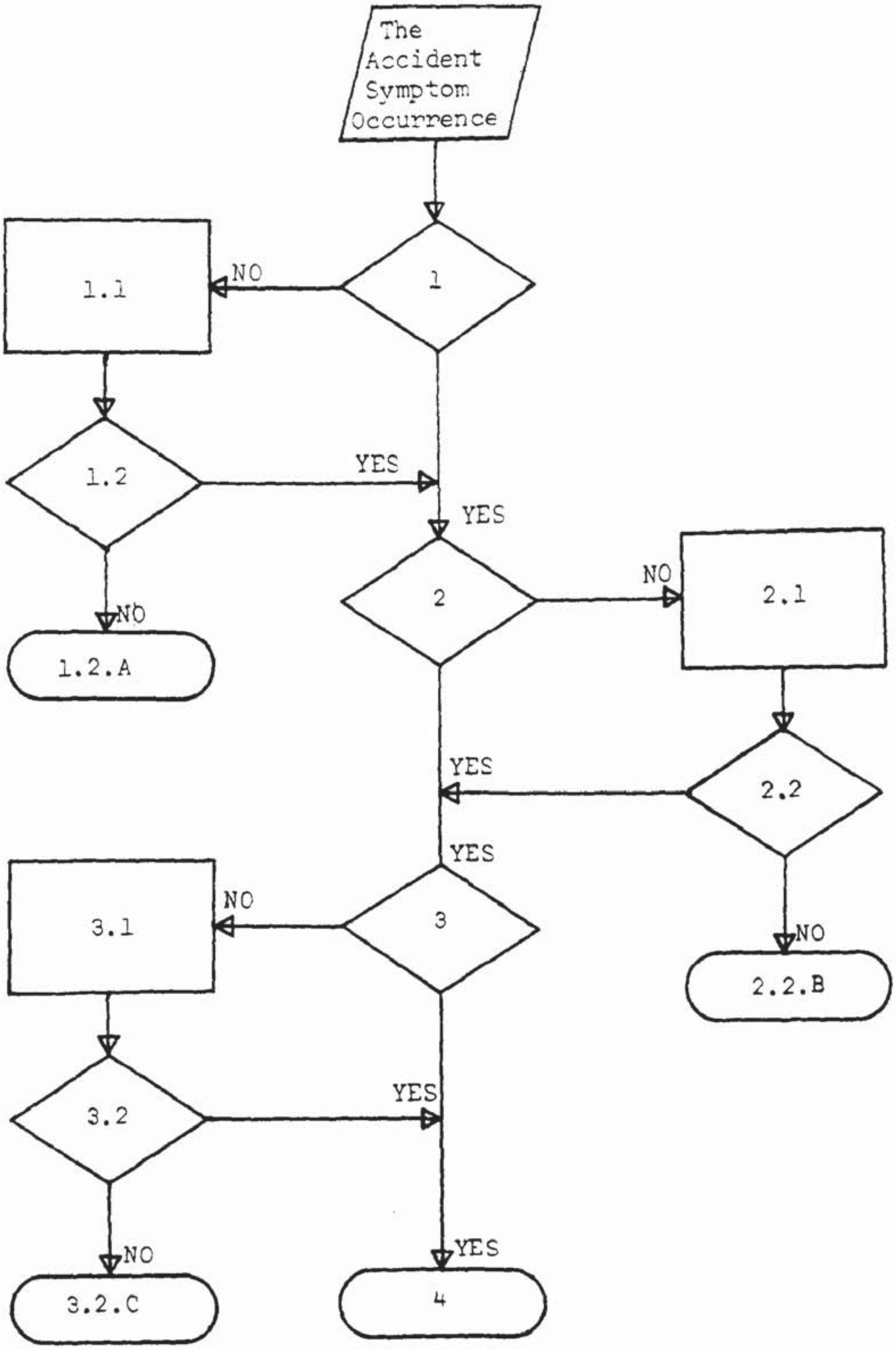

Fig 3

The Flowchart of the Interview Sequence

The Legend to the Flowchart

1. Did the supervisor recognize the accident symptom occurrence by himself?

1.1 Reasons for answering NO to 1

1.2 Did the supervisor agree that it was an accident symptom occurrence when pointed out?

1.2.A Reasons for answering NO to 1.2

2. Did the supervisor think that he should deal with the accident symptom occurence?

2.1 Reasons for answering NO to 2

2.2 Did the supervisor agree that the accident symptom occurrence should be dealt with by somebody?

2.2.B Reasons for answering NO to 2.2

3. Did the supervisor know a suitable method of dealing with the accident symptom occurrence?

3.1 Reasons for answering NO to 3

3.2 Was a suitable method agreed upon by the supervisor and the researcher?

3.2.C Reasons for answering NO to 3.2

4. Any reasons not given above for the presence of the accident symptom occurrence.

of supervisors for part 2 of the study. The main aim therefor was to gather information from a large variety of supervisor/workplace units on the basis of dimensions which seemed relevant according to Chapters 2 and 3, to identify as many important variables influencing the safety role of the supervisor as possible, rather than to assess the relative influences of these factors. Seventy supervisors working in fifty different sites belonging to 13 different constrution firms were used in the field investigation. They were interviewed on a total of 659 accident symptom occurrences. A detailed description of the field study and a presentation of these data are given in Chapter 7.

The sample of projects selected for detailed examinations in part 3 of the study was limited to 3 sites from 3 different firms. 4 supervisors, 2 Site Agents, 3 Project Managers, and 3 Safety Officers were included in this investigation. The selection of the projects was guided by the findings of part 2 of the study, and had to be limited to the firms and sites from whom co-operation could be obtained to the high degree of involvement required (see Chapter 9).

5.7 Summary and Conclusions

The methodology used in this study was tailor-made to suit its specific requirements.

A problem-centred investigation using techniques based on a descriptive discovery design was decided to be the most appropriate method for this research.

An understanding of the perception and interpretation of the large number of variables concerning critical elements relating to safety, and their interaction was considered

essential for a study of the safety role of the supervisors. An interview method, with the investigator playing the role of 'observer as participant' was chosen to be used in the field investigation.
In the absence of an established method to identify crucial elements concerning safety, to use as stimuli for site interviews, development of such a method was found necessary. This was achieved by drawing up, from reports of accidents in construction sites, a list of accident symptoms as general descriptions of safety inadequacies of sites. The interviews were conducted according to a model developed to highlight the supervisory decision process concerning accident symptoms, the factors influencing those decisions and the ability of the supervisors to deal with the accident symptoms.

A number of characteristics seem crucial for a method to be successful in a specific investigation. Firstly, it should effectively highlight safety problems and safety training objectives in the case of an on-going construction situation at any particular point in time. Secondly, it should effectively highlight the supervisor's own perceptions as regards the factors likely to influence his performance and behaviour relating to those problems. Thirdly, the method should be clear to the supervisors' superiors and others concerned, and the information generated meaningful, so as to permit a diagnosis of the determinants underlying supervisory behaviour.

The field investigations consisted of two phases. One, a general study of a large number of supervisor/site units to generate a list of factors influencing site safety as perceived by the supervisors. The other, carried out specific studies of four supervisors on three sites, incorporating the perceptions of the supervisors' superiors as well as those of the respective Safety Officers.

CHAPTER 6

DERIVATION OF ACCIDENT SYMPTOMS

- PART 1 OF THE STUDY -

6.1 Analysis of Accidents

In order to develop the list of accident symptoms for identifying safety inadequacies in sites, reports of accidents were collected from firms of a wide range of sizes. In the absence of a basis upon which a representative sample of accident reports could be selected, accidents from a large variety of construction operations were used. The distribution of the accidents according to the Type of Construction, Size of Firm and Size of Site are given in tables 2, 3 and 4 respectively. These tables indicate that the sample is well spread over a wide spectrum. The reports used were those available from different records kept by the firms (eg. safety records, first aid records, personal records etc.) and were of all accidents not just those which were reportable.

The main objective of this part of the study was to arrive at a general classification of all accident producing circumstances on construction sites, rather than making a comparative study. The degree of reporting on any particular construction organization, whether good or bad, therefore, was not significant. The important thing was to study a sufficently large number of accidents from a wide variety of activities, to ensure that the classification was reasonably complete.

The description of each accident was assembled as far as possible from the records and the contributory causal factors that had been identified were noted. These factors were all descriptions of one of the situational components, work setting, personnel, provision and system of work discussed in the preceding chapter. Each causal factor was then classified under a heading of general description applicable to a group of similar factors. For example, all contributory causal factors

TABLE 2

Distribution of Accidents According to Type of Construction

Type of Construction	Number of Sites	Number of Accidents
1. New Dwelling Construction	28	183
2. New Public and Commercial Building Construction	16	98
3. New Industrial Construction	11	96
4. New Works of Civil Engineering Construction	41	202
5. Work on Existing Structures of All Types (Repairs, Maintenance Conversions, Improvements etc)	20	126
TOTAL	116	705

TABLE 3

Distribution of Accidents According to Size of Firm			
Size of Firm (Numbers Employed)	Number of Firms	Number of Sites	Number of Accidents
A. 1 - 24	7	15	104
B. 25 - 114	9	20	179
C. 115 - 1,199	10	43	198
D. 1200 and above	2	38	224
TOTAL	28	116	705

TABLE 4

Distribution of Accidents According to the Size of the Site		
Size of the Site (Estimated Value £)	Number of Sites	Number of Accidents
Up to 100,000	31	181
Over 100,000 up to 200,000	44	203
Over 200,000 up to 500,000	23	160
Over 500,000 up to 1,000,000	11	74
Over 1,000,000	7	87
TOTAL	116	705

of the type described as instability of an item, whether it be a plant, equipment, stack, excavation side etc. were listed under the heading, lack of stability which thus became an accident symptom in the general category of the work setting. Thus a classification system emerged from the accident data. An example of the categorisation as applied to a specific accident, is given below.

> "A workman stepped on a nail protruding from a piece of timber while walking to his work place, and injured his foot. He was not wearing safety shoes, nor had they been provided to him. The timber had been dismantled from a shuttering and was lying on the floor in a passageway. There was no separate space to store stripped timber. The injured workman was sent to hospital for treatment, since suitable first aid facilities and a first aider were not available on the site".

Causal factors cited in this accident (upon which corrective measures may have been recommended), when expressed as characteristics of the situational components, appear as follows:

Work Setting

(1) Presence of a protruding object likely to cause injury.

(2) Accumulation of stripped timber in a passageway.

Personnel

(1) The method used by the workmen who stripped the shuttering was unsafe - ie. the nails were not hammered down, or the timber was not denailed while stripping. Also they had thrown the timber on the passageway floor.

(2) The injured workman was not wearing safety shoes.

(3) A person trained in first aid was not available on the site.

Provisions

(1) Non-provision of a facility needed for safety in the site

- ie. a separate area had not been allocated to accumulate the stripped timber.

(2) Safety shoes had not been provided to the workman.

(3) First aid facilities had not been provided on the site.

System of Work

(1) Absence of an effective system to ensure that the stripped timber was de-nailed or the nails were hammered in, while being dismantled.

(2) Absence of a system to ensure that the stripped timber was thrown onto an area separated out for that purpose.

The collection of accident reports and the derivation of accident symptoms from them was continued until no new accident symptoms appeared for a consecutive hundred accident reports, ie. all the contributing causal factors cited in the last one hundred accident reports could be classified under the accident symptoms already listed from the previous reports. This stage of the study was therefore self-limiting, and it was considered unlikely that a larger sample of accident reports would have yielded further sub-headings. This fact was considered to be adequate evidence that the list formed was sufficiently comprehensive to use as a basis for identifying safety inadequacies in the sites for the purpose of this study. The number 100 was, in a sense an arbitrary number which was considered a reasonable target, bearing in mind the time available for this research.

Accident symptoms were found to show themselves as inadequacies in one or more of the following broad categories.

1) Worksetting, provision, personnel and/or system, relative to the purpose for which they were required.

2) The diagnostic and/or hazard detection measures required.

3) The preventive measures that were necessary.

4) The corrective and/or hazard control measures that were necessary.

5) The ameliorative measures that were necessary.

6) Other safety activities and measures necessary.

Accident symptoms in category 1 are causal factors representing weaknesses in the resources and procedures used to meet the operational demands of construction. Those in categories 2 to 6 are weaknesses in the adoption of the different types of safety measures necessary against hazards in the particular work place.

Table 5 presents the accident symptoms derived in this study, indicating the category of inadequacy and the situational component to which each belongs. The number opposite each accident symptom is the number of accidents in which the particular accident symptom was a causal factor.

There was no way of verifying whether the sample of accidents used was representative of all construction accidents or not, and so it is not possible to use the data to assess the relative degree of occurrence of particular types of accident symptoms. The exercise was aimed at collecting a comprehensive total list of accident symptoms by covering a wide variety of firms and sites rather than evaluating their relative importance. Therefore the sample was designed to cover a range rather than to be representative.

6.2 Accident Symptoms

This section consists of an outline of each of the 55 accident symptoms that were derived in the present research. The outline of each symptom falls into two parts. The first part is a description of it in terms of how it may manifest itself, along with illustrative examples where these are felt to be necessary for clarification. The second part is a statement of the criterion (called the criterion of safety inadequacy) used to decide whether the particular accident symptom was present or not on a site. The accident symptoms were discussed

TABLE 5

Distribution of Accidents According to Accident Symptoms

Category of Accident Symptoms	Worksetting	No. of Accs.	Provision	No. of Accs.	Personnel	No. of Accs.	System of Work	No. of Accs.
1. Inadequacies of the resources and procedures used for the operations	i. Lack of Stability	86	i. Lack of Quality and Quantity	145	i. Lack of Ability of the Personnel	164	i. Systems of Manual Handling Unsuitable	94
	ii. Unsuitable Construction and Condition	117	ii. Lack of Fitness	80	ii. Persons Using Unsound and/or Unsuitable Construction Items		ii. System of Mechanical Handling Unsuitable	42
	iii. Unsuitable Loading	59	iii. Lack of Suitability	43	iii. Persons Using Inappropriate Methods and Techniques	120	iii. System of Transport Unsuitable	38
	iv. Improper Positioning of People and Objects	143	iv. Harmful Construction material	73	iv. Persons Conducting Themselves in an Improper Manner	187	iv. System of Movement and Placement of Personnel and Objects Unsuitable	91
	v. Improper stacking and Storing of Objects	47	v. Harmful Construction Equipment Machinery and Tools		v. Presence of the Public and Other More Vulnerable Personnel	28	v. System of Operations Unsuitable	115
	vi. Accessible Edges and Openings	91						
	vii. Protruding Objects	68						
	viii. Obstructions	71						
	ix. Flying and Falling Objects	85						

continued...

TABLE 5 continued

Category of Accident Symptoms	Worksetting	No. of Accs.	Provision	No. of Accs.	Personnel	No. of Accs.	System of Work	No. of Accs.
	x. Harmful Agents in the Atmosphere	38						
	xi. Improper Supply and Service Lines	20						
	xii. Inappropriate Site Lay-out	26						
	xiii. Inadequate Visibility	52						
	xiv. Proximity to and Accessibility by the Public	34						
2. Inadequacies of the Diagnostic and/or Hazard Detection Measures Necessary	i. Location of Persons and Equipment to Diagnose, Detect and Monitor Hazards, Less Than Adequate	67	i. Facilities Provided for the Purpose of Diagnosing Detecting and Monitoring Hazards Less Than Adequate	105	i. Persons Assigned with the Functions of Diagnosing Detecting and Monitoring Hazards Less Than Adequate		i. System of Diagnosing and Monitoring Hazards, Less Than Adequate	102

continued...

TABLE 5 continued

Category of Accident Symptoms	Worksetting	No. of Accs.	Provision	No. of Accs.	Personnel	No. of Accs.	System of Work	No. of Accs.
2. Inadequacies of the Diagnostic and/or Hazard Detection Measures Necessary	ii. Location and Condition of Warnings, Cautions and Hazard Indicators Less Than Adequate	90	ii. Facilities for the Purposes of Warnings, Cautions and Indicators, Less Than Adequate	57	ii. Persons Failing to Obey the Warnings. Cautions and Indicators	61	ii. Systems of Warning, Caution and Indication Less Than Adequate	86
3. Inadequacies of the Preventive Measures	i. Location of the Facilities and Personnel Engaged in the Preventive Functions Less Than Adequate	32	i. Facilities Provided for Preventive Purposes Less Than Adequate	172	i. Personnel Engaged in Preventive Functions Less Than Competent	88	i. Systems of Adopting Preventive Measures Less Than Adequate	94
4. Inadequacies of the Corrective and Control Measures	i. Location, Construction and Condition of the Corrective and Control Measures Less Than Adequate	112	i. Facilities Provided for Corrective and Control Functions Less Than Adequate	196	i. Persons Failing to Adopt Corrective and Control Measures and Use Those Facilities	122	i. Systems Adopted for Corrective/ Control Measures Less Than Adequate	170

Continued...

TABLE 5 continued

Category of Accident Symptoms	Worksetting	No. of Accs.	Provision	No. of Accs.	Personnel	No. of Accs.	System of Work	No. of Accs.
5. Inadequacies of the Ameliorative and Emergency Measures	i. Location and Layout of Escape, Rescue and Fire Fighting Arrangements Less Than Adequate	30	i. Facilities for Escape and Fire Fighting Less Than Adequate	39	i. Ability of Personnel in Escape, Rescue and Fire Fighting Activites Less Than Adequate	23	i. Systems of Escape, Rescue and Fire Fighting Less Thank Adequate	17
	ii. Location of First Aid and Emergency Medical Care Less Than Adequate	36	ii. Facilities for First Aid and Emergency Medical Care Less Than Adequate	45	ii. Competence of Personnel in First Aid and Emergency Medical Care Less Than Adequate	89	ii. Systems of Ensuring First Aid and Emergency Medical Care Less Than Adequate	38
6. Inadequacy of Other Relevant Measures	i. Location of Welfare Facilities Less Than Adequate	14	i. Quality and Quantity of Welfare Facilities Less Than Adequate	30				
		1318		1087		882		887

in the order in which they appear in Table 5.

6.2.1 Work Setting

1. Resources and Procedures

i. Lack of Stability

Causal factors described by this term were the lack of stability of a variety of items such as plant, equipment, materials, tools, stacks, excavation sides, temporary and permanent structures, etc. as well as persons. Instability was found to be a function of the items concerned, the environment (eg. wet and slippery floor, high winds etc.) and/or the operations and activities in progress. A crane could be unstable because of the nature and unevenness of the ground, failure to use a proper ballast or necessary out-riggers, or incompetent operation. A man could be unstable because he was supported on a narrow unprotected beam, was too old, drunk, or because he overstretched from a ladder. In all cases the recognisable characteristic at the operation system level which needs checking for adequacy is 'stability'. It needs to be borne in mind that for certain operations such as demolition, instability is purposely created to bring about a collapse ie. certain cases of lack of stability are unavoidable in construction operations. Precautionary measures are necessary in such cases.

The criteria of safety inadequacy were, whether there was lack of stability in the parts of the work setting, and whether adequate precautionary measures had not been taken where sufficient stability could not be ensured.

ii. Improper Construction and Condition

This term refers to the soundness of construction and condition of maintenance of parts of the work setting, such as places of work, plant, equipment, structures, means of access and egress etc. Whether the construction was adequately sound depended upon the purposes for which the particular item was used, the nature of the environment, as well as the type of activities carried out. For example, a scaffolding should be constructed to carry the intended loads, to withstand the effects of rain, wind, temperature variations etc. and also to accomodate added stresses such as impacts and eccentric loads which might be imposed by the type of activities. The adequacy of the condition of the items depended on the environment, the activities and time, eg. the condition of the supports to an excavation side would change either after inclement weather conditions, or due to the operations carried out in and around the excavations. In addition the components of the supports could also deteriorate with time. The criterion of safety inadequacy therefore, was whether the construction and condition of work setting parts were less than adequate in the circumstances.

iii. Improper Loading

Improper loading of parts of the work setting such as structures, equipment, plant, floors etc. were cited as causal factors. Improper loading was found to take many forms. Overloading, impact loading, eccentric loading, uneven loading, unsuitable load distribution, insecure loading, and projecting loads were the common ones. Adequacy of the nature of loading depended upon whether the loading was compatible with the stability, construction and condition of the support (whether it could satisfactorily withstand the load in that form), the work environment (whether the surrounding activities and environmental characteristics would render it unsatisfactory and the nature of the loading items (eg. shape, size, weight, volume, etc.) and other properties of importance associated with those items (eg. explosiveness, toxicity, flammability etc.).

The criterion of safety indequacy was, whether the way in which each work setting part was loaded was less than adequate.

iv. Improper Positioning of People and Objects

The way people and objects had been positioned within the work setting was among the causal factors mentioned in a variety of types of accidents. People and objects were found to be the sources and/or victims of accidents in certain settings as a result of their proximity to other parts of the work setting (eg. positioning of men, plant, vehicles, and materials near insecure places such as unprotected edges and openings, falling or flying objects etc.). The inadequacy of the way they were positioned was found to be dependent upon the nature of the people and objects in relation to the nature of the proximate environment, (eg. inexperienced persons on fragile roofs by themselves, flammable substances and liquified petroleum gas (LPG) cylinders in proximity to burner equipment or hot air currents, heavy vehicles near the edges of excavations etc.).

The criterion of safety inadequacy was, the lack of safety compatibility of the persons and objects with the proximate environment in which they were positioned.

v. Improper Stacking and/or Storing of Objects

The appropriate ways of stacking/storing different types of objects in a work setting would be different. Failure to stack/store objects in a manner that was suitable for them in the particular work environment was cited as a causal factor in a variety of accidents which occurred as a result of collapse, deterioration, fire, explosions etc.. For example flammable and explosive substances, equipment and their components, and different types of construction materials have particular ways in which they should be stacked and stored safely.

The criterion of safety inadequacy was whether the way all the work setting items were stacked and/or stored was less than suitable.

vi. Accessible Edges and Openings

Certain edges and openings in a work setting need to be protected by barriers to prevent the fall of persons, material, equipment, vehicles, tools etc.. The need for such barriers was found to depend upon whether persons and objects had access to those edges and openings, in the particular work environment.

However, there were certain edges and openings which, in spite of persons having access, had to be left unprotected, for example, scaffolding platforms while being erected, excavation edges before erecting barriers etc.. In such cases, precautionary measures, such as the use of work people specially trained and skilled to cope with them, the use of safety nets, belts, harnesses, etc. were necessary.

The criterion of safety inadequacy was, whether those edges and openings which needed protection had not been adequately protected.

v. Protruding Objects

The presence of certain protrusions in the work setting was cited as a causal factor in certain types of accidents (eg. protruding nails in timber, scaffold tubes protruding out of the structure, re-inforcement steel protruding into passageways etc.). Adequate precautions had to be taken to deal with those which could not be avoided.

The criterion of safety inadequacy was, the presence of protruding objects that were potential sources of harm.

vii. Obstructions

Obstructions in gangways, stairs, working areas etc.and in the path of vehicle, plant and equipment traffic were among the causal factors cited in the cases of accidents concerning occurrences such as stumbling and tripping of persons and accidents to plant and vehicles. Whether an obstruction in a work setting was a safety inadequacy depended upon whether it had the potential to contribute towards a harmful occurrence. The nature of the obstruction as well as that of the work environment were therefore, both important. If any obstructions were unavoidable, adequate precautions should have been adopted to cope with them.

The criterion of safety inadequacy was the presence of harmful obstructions in the work setting.

ix. Flying and Falling Objects

Many construction activities involve flying objects (eg. use of explosives, dry grinding and wire brushing of metal, stone, concrete etc, breaking and cutting of stones and concrete, throwing of objects for various reasons etc.) and falling objects (eg. loose materials and tools falling from heights or into excavations, demolition operations, objects purposely dropped from scaffolds etc.).

These were found to be among the causal factors in a variety of accidents. They could be categorised into twc types; those that fell or flew inadvertently during the course of normal activity, and those which were deliberately caused (eg. dropping tools and material from one floor to another).

The criterion of safety inadequacy was the presence of flying or falling objects in the work setting, against which adequate precautionary measures to avert harm had not been taken.

x. Harmful Atmospheric Agents and Conditions

Various agents in the atmosphere such as dust, gas, fumes, radiation, noise, vibrations, heat, cold, wind, etc and lack of oxygen, were found to be causal factors in a variety of accidents in construction operations. The precautionary measures appropriate were dependent upon the nature of the agent and the particular work environment.

The criterion of safety inadequacy was the presence of these harmful agents in the atmosphere, and their sources in the work situation without adequate precautions being adopted to deal with them.

xi. Harmful Materials

Harmful solid and liquid substances (eg. waste material and flammable, explosive, toxic, corrosive etc substances) were among the causal factors in certain types of construction accidents. When they were an essential part of the construction operations a variety of precautionary measures were necessary depending on substance and the work situation.

The criterion of safety inadequacy was the presence of any harmful material in the work situation without adequate precautions being taken to prevent its harmful effects.

xii. Improper Supply and Service Lines

Inadequacies in the ways in which supply and service lines (eg. temporary and permanent electricity lines, pipe lines for air, gas, water, steam, sewers, waste etc and drainage arrangements) were laid in the work site were categorised under this heading. The lines were overhead, underground or on the surface.

The criterion of safety inadequacy was the lack of sufficiency and suitability of these lines for their purposes as well as in the way they were laid, supported and protected in relation to the particular work environment.

xiii. Inappropriate Site Lay-Out

The site lay-out was considered to include the external boundaries of the site, the internal boundaries separating it into sections, the positioning of temporary and permanent structures, access into and egress from the site, internal roads and transport layout, the provisions of access to and egress from different work places etc. and their arrangement within the setting. Accidents were found to have causal factors which related to deficiencies in the layout of the site. The detailed characteristics of the lay-out were related to the nature of the work environment as well as to activities adjacent to it (eg. clearly visible barriers, signs, lights etc. in road construction to mark and identify the site).

The criterion of safety inadequacy was the lack of suitability of the site layout arrangements in relation to the circumstances.

xiv. Lack of Adequate Visibility

Accident causal factors included conditions of inadequate visibility due to a number of factors in the work setting (eg. lack of sufficient daylight, lack of illumination and spread of light provided, fog, steam or smoke etc.).

Certain areas of the work setting such as shafts, dark corners, stairways, etc. required special light at all times.

Certain operations, eg. lifting, work in water and specific places such as dangerous openings and edges through which persons might fall, also required special lights.
The criterion of safety inadequacy was the lack of adequate visibility.

xv. Proximity and Accessibility to the Public

Here, the term public refers to all personnel other than those who were associated with the construction activities. Works in premises partly or fully occupied, easily accessible to outside personnel or adjacent to other establishments, residences and public areasneeded additional measures for the protection of the public (eg. erection of fans and safety nets where the public is likely to pass by, barricades and other protection on the outer boundaries etc.).Proximity and accessibility to the public were cited as causal factors in certain accidents.
The criterion of safety inadequacy was the proximity or the accessibility of the construction operations to the public without adequate precautionary measures being taken.

2. Diagnostic/Hazard Detection Measures

I Location of personnel and equipment for diagnostic, detection and monitoring.functions less than adequate

Absence of persons who were assigned the tasks of detecting, diagnosing and monitoring activities and safety problems in the work setting, as well as the equipment necessary for such purposes at the proper locations in the site was a causal factor in some accidents (eg. banksman, signalman, persons and equipment in enclosed places such as shafts, pits, tunnels, etc where dangerous atmospheric contaminants may be present.

The criterion of safety inadequacy was the failure to have suitable personnel and equipment for the stated functions properly located.

II. Location and condition of warnings, cautions and danger indicators less than adequate

In certain cases of construction hazards, it was found that warnings, cautions and danger indicators were depended on as a means of detecting the hazards. Lack of proper location of these were among the accident causal factors (eg. warnings at partly erected scaffolds and fragile material, warning barriers near overhead supply cables to prevent contact, signalling alarms, danger and caution signs, special safety instructions etc.).

The criterion of safety inadequacy was the failure to have the necessary indicators properly located.

3. Preventive Measures

I. Location of the facilities and personnel engaged in preventive functions less than adequate

Certain construction activities required the suitable location of facilities and persons to prevent some types of hazards being built-up. (For example separate rubbish areas suitably located to prevent a build-up of obstructions, protruding objects, flammable material etc on the site. Also, proper chutes or other means to prevent material and objects being thrown down from one level to another. Positioning of suitable skilled and experienced personnel to supervise scaffold erection, excavation-support erection etc.) Failure to locate these facilities and persons in a suitable manner was an accident causal factor.

The criterion of safety inadequacy was the lack of suitable facilities and personnel for preventative functions being properly located.

4. Corrective and control measures

I. Location of measures for correcting and controlling dangers less than adequate

Failure to locate protections against dangers (eg. barriers at edges and openings, ventilation facilities, fencing of machinery, safety nets etc) suitably, and maintain them in an effective condition were causal factors in certain accidents.

The criterion of safety inadequacy was the failure to have suitable corrective and control measures properly located.

5. Ameliorative emergency measures

I. Location of necessary escape, rescue and fire-fighting arrangements less than suitable

Certain operations and activities (eg, working in confined spaces, shafts, tunnels, excavations, water etc.) need provision of escape routes and rescue arrangements to cope with incidents arising out of their particular hazardous nature. Inadequacy in the location and layout of escape, rescue and fire-fighting arrangements, where necessary, was cited as a contributory factor in certain types of accident. Visibility, access and likelihood of damage by other operations were common problems of location.

The criterion of safety inadequacy was the failure to have suitable escape, rescue and fire-fighting arrangements properly located.

II. <u>Location of the necessary first aid and emergency medical care unsuitable</u>

Problems concerning the location of these facilities within or in relation to the work site were factors in aggravating the severity of injuries due to accidents. Problems concerning access to what was provided were the most common.

<u>The criterion of safety inadequacy was</u> the failure to have suitable first aid and emergency care properly located.

6. <u>Other relevant measures</u>

I. <u>Location of the necessary sanitary and welfare facilities unsuitable</u>

Certain accident reports mentioned that these facilities (eg. toilet facilities, drinking water, shelters, washing facilities, meal rooms etc.) were not located in convenient places. Although they were not cited as causal factors, the reports considered them as aspects relevant to safety in the sites.

<u>The criterion of safety inadequacy was</u> the failure to have suitable sanitary and welfare facilities properly located.

6.2.2 <u>Provision</u>

1. <u>Resources and procedures</u>

I. <u>Lack of quality and quantity</u>

Deficiencies in the quality and quantity of items made available for the construction operations (eg. premises, plant, equipment, machinery, tools, materials, services etc.) as well as non-availability of them altogether were found to be causal factors in a variety of accidents. The suitability of quality and sufficiency of these items were directly related to the purposes for which they were to be used and the nature of the particular work environment (eg. in the case of a crane, the load and reach capacities and the stability characteristics had to suit material to be handled and the conditions in which the work took place).

The criterion of safety inadequacy was the lack of quality or sufficiency of the items made available for the operations.

II. Lack of fitness

Fitness for use of items made available included being in proper working order with all safety measures, guards, controls, indicators etc. functioning correctly and being properly maintained with examinations, inspections and tests being carried out as required. Defective material, lack of proper functioning of brakes, guards, interlocking mechanisms, hazard indicators and other characteristics which rendered the items unfit for safe use as well as the fact that periodic examinations and tests as required had not been performed were therefore all indications of the lack of fitness.

The criterion of safety inadequacy was the lack of fitness of items made available for the operations.

III. Lack of suitability

Construction materials, equipment and other items provided were, in some cases of unsuitable type (eg. inappropriate tools, inappropriate machines, inappropriate plant etc.). This was a causal factor in some accidents.

The criterion of safety inadequacy was the lack of suitability of the stated items.

IV. Harmful construction material

Certain construction materials were found to present potential

injury and health hazards which necessitated special control measures for handling, storage and use. Some examples were toxic and irritant substances, carcinogens, explosive and flammable substances. Provision of these materials without ensuring that the essential control measures were adopted was a causal factor in accidents.
The criterion of safety inadequacy was the presence of harmful construction material without the necessary precautions.

v. Harmful construction machinery, tools, and equipment
Certain construction machinery, tools, and equipment were found to present injury and health hazards (eg. dangerous moving parts, pneumatic drills, cartridge hammers, emission of carbon monoxide, mobile towers etc.) which required special control measures for handling, storage and use. These items were causal factors in accidents when adequate precautionary measures had not been adopted.
The criterion of safety inadequacy was the engagement of harmful construction machinery, tools and equipment without adopting adequate precautionary measures.

2. Diagnostic/Hazard detection measures

I. Facilities for diagnostic, detection and monitoring functions less than adequate
Lack of suitable and sufficient facilities necessary to carry out these functions (eg. inspections, tests, examinations, monitoring etc.) was a causal factor in certain accidents.

II. Facilities for warning, cautions and indicators, less than adequate
Lack of facilities necessary to provide the warnings, cautions and indicators (eg. alarms, danger notices, warnings, barriers

etc.) that were required in the case of those hazards where they were necessary was cited as an accident causal factor. The criterion of safety inadequacy was the lack of adequacy of the stated facilities.

3. Preventive measures

I. Facilities for preventative functions less than adequate

Preventative functions are those concerned with preventing the build-up of danger altogether (eg. periodic maintenance of equipment, discarding of defective material and equipment etc.). Lack of adequate facilities necessary to carry out these functions were among the causal factors.
The criterion of safety inadequacy was the lack of adequacy of the necessary preventative facilities.

4. Corrective and control measures

I. Facilities provided for corrective/control functions less than adequate

Failure to provide facilities necessary for corrective control functions necessary to deal with potential hazards (eg. barriers at edges and openings, ventilation, erection of additional supports etc. and the lack of sufficient and suitable items of personal protection (eg. safety helmets, goggles, respiratory protective equipment, safety shoes etc.) where necessary were causal factors in some accidents.
The criterion of safety inadequacy was the lack of adequacy of the necessary corrective/control measures.

5. Ameliorative emergency measures

I. Facilities for escape, rescue, and fire-fighting less than adequate

In the case of certain construction operations it was necessary to provide facilities for escape and rescue operations where there was a potential danger release (eg. floods in cofferdams, work in confined areas etc.) failure to provide sufficient and suitable facilities for these purposes and/or fire fighting were causal factors in some accidents.

The criterion of safety inadequacy was the lack of adequacy of the stated facilities.

II. Facilities for first aid and emergency medical care, less than adequate

The inadequacies of facilities for first-aid and emergency medical care necessary in particular construction activities, were found to be factors aggravating the consequences of some accidents.

The criterion of safety inadequacy was the lack of adequacy of these facilities.

6. Other relevant measures

I. Less than adequate welfare facilities

Inadequacies of welfare facilities, such as sanitary conveniences, drinking water, shelters, washing facilities, mess rooms, were cited in accident reports as indicative of less than satisfactory conditions of work. These were therefore considered as characteristics of safety on sites.

The criterion of safety inadequacy was the lack of adequacy of the necessary welfare facilities.

6.2.3 Personnel

1. Resources and Procedures

I. Lack of ability to carry out the assigned tasks safely

This heading refers to the ability of personnel engaged in construction activities regarding the operational requirements of the tasks they had to carry out during the course of their work. Lack of such ability was a causal factor in some accidents. Characteristics of competence (eg. knowledge, skill, training and experience) and those of physical and psychological fitness (eg. disability, intoxication, tiredness, illness, age etc.) were the most important in this respect. The criterion of safety inadequacy was the lack of ability to carry out the assigned tasks without resulting in an accident.

II. Failure of the persons to use sound and/or suitable provisions

The use of plant, equipment, tools, materials etc. that were damaged and/or not suitable for the particular purpose was found to be a causal factor in a variety of accidents. In a majority of construction activities, the decision as to the provisions which should be used in a particular task was taken by the individual himself, eg. whether to use a proper ladder or an improvised arrangement to reach a height. If the provisions used were less than adequate for the purpose when adequate provisions were available, it was considered to be a short fall of the personnel component of the situation. The criterion of safety inadequacy was the use of unsound or unsuitable provisions by persons.

III. Methods and techniques used less than adequate

The use of suitable methods and techniques in the performance of tasks, was cited as a causal factor in certain accidents. The methods of carrying out most tasks in construction operations are decided by the individual himself (eg. correct use of ladders and mobile scaffolds, the proper operation of plant and equipment etc.). Failure to adopt a suitable technique in performing a task was considered to indicate an inadequacy of the person.

The criterion of safety inadequacy was the use of inappropriate methods and techniques by persons.

IV. Improper conduct of personnel

This refers to the general conduct of people within the site. Work behaviour as well as non-work behaviour was considered important. The category included, unsafe and unauthorised conduct, deliberate disturbance of proper functioning of safety provisions and other functional items which might cause danger, and misbehaving in general within the site. Such conduct of persons was a causal factor in some accidents.

The criterion of safety inadequacy was the improper conduct of personnel.

V. Presence of personnel outside the construction team

Presence of personnel other than those belonging to the construction team, especially those not familiar with the particular type of construction activities was a causal factor in some accidents.

The criterion of safety inadequacy was the presence of such personnel without special measures being adopted for their safety when necessary,

2. Diagnostic/Hazard detection measures

I. Persons assigned the functions of diagnosing, detecting and monitoring hazards, less than competent

Certain functions, crucial for safety, such as monitoring, inspection, examining, testing, authorising etc. had to be carried out by persons who were competent. Inspection of scaffolds and excavations, examination of lifting appliances and other equipment are some examples. Lack of competence of persons responsible for performing these functions was a causal factor in some accidents.

The criterion of safety inadequacy was the lack of adequate competence in persons assigned with those functions.

II. Failure of persons to obey warnings, cautions and other indications

Causal factors of some accidents included failure of persons to obey warnings, cautions and other safety indicators.

The criterion of safety inadequacy was the failure by persons to heed such indicators.

3. Preventive Measures

I. Personnel engaged in preventative functions less than competent

Certain hazardous construction activities require competent persons to be engaged in preventing accidents in those activities. Some examples are, the use of explosives, demolition operations, and shoring of excavations. Lack of competence of these people was among causal factors cited in accidents.

The criterion of safety inadequacy was the lack of competence in persons engaged in such preventative functions.

4. Corrective and Control Measures

I. Persons failing to use control facilities and to adopt control procedures

Certain hazards necessitate the adoption of extra precautionary

measures (eg. precautions in the use of L.P.G. cylinders, work on fragile roofs, transport of explosives and detonators etc.) the use of special working gear (eg. distinctive fluorescent protective garments for road workers) or the use of personal protection (eg. safety helmets, goggles, buoyancy aids for those working over water etc.). Failure of persons to adopt these measures was among the causal factors.
The criterion of safety inadequacy was the failure to use control facilities and adopt control measures appropriately.

5. Ameliorative and Emergency Measures

I. Competence of personnel who need to carry out escape, rescue, and fire-fighting functions, less than adequate (post-accident)

Lack of competence of persons responsible for these functions was cited as a causal factor for increasing the ill-effects of accident occurrences.
The criterion of safety inadequacy was the lack of competence of persons assigned to these functions.

II. Competence of personnel in charge of first-aid and emergency medical care, less than adequate

Lack of competence of these personnel was a factor aggravating injuries and health disorders of accident victims.
The criterion of safety inadequacy was the lack of competence of such personnel.

6.2.4. System of Work

1. Resources and Procedures

I. System of manual handling less than adequate

Weakness in the systems, (procedures, techniques and sequences followed) adopted in the process of manual handling of articles was a causal factor in some types of accidents. Systems had to be appropriate to the type of article and the particular work environment concerned.

The criterion of safety inadequacy was the lack of adequacy of the system of manual handling.

II. System of mechanical handling less than adequate

The system of mechanical handling adopted also had to suit the machines, the articles handled, and the work environment in which the operations were carried out. Inadequacies in the systems adopted were cited as causal factors, in certain accidents (eg. the use of cranes, dumpers etc.).

The criterion of safety inadequacy was the inadequacy of the system of mechanical handling.

III. System of transport less than adequate

The system of transport used in the conduct of construction operations, also had to be appropriate to the vehicles, equipment and/or plant, the article transported and the particular work environment concerned (For example systems to ensure traffic control, speed limits, clearances, distances from excavations etc., as well as special transport systems in the case of dangerous materials such as explosives and detonators, flammable substances etc.). Inappropriate transport systems were causal factors in some accidents.

The criterion of safety inadequacy was the inadequacy of the system of transport.

IV. System of movement and placement of personnel and objects, less than adequate

This refers to the system adopted with regard to where, when and how persons and objects should be either placed or moved during the site activities in a particular work environment. Weaknesses in such systems were among accident causal factors (eg. workmen and objects being moved or placed in demolition areas, firing ranges of explosives etc).

The criterion of safety inadequacy was the inadequacy of the stated systems.

V. System of operations less than adequate

This refers to the way the activities of a particular operation are arranged and the way the operations are arranged in relation to one another and the other situational factors concerned (eg. system of demolition, system of erection of pre-cast units etc.). Inadequacies in the systems used for such arrangements were causal factors in certain accidents.

The criterion of safety inadequacy was the inadequacy of the system of operations.

2. Diagnostic/Hazard Detection Measures

I. Systems for diagnosing detecting and monitoring hazards less than adequate

In the case of certain site activities, operations, machinery, plant, equipment, materials etc. it was found necessary to have a suitable system of diagnosing and detecting hazards by procedures such as monitoring, inspection, testing, examination etc.. Lack of a proper system to ensure that these functions were carried out was an accident causal factor.

The criterion of safety inadequacy was, inadequacy in these systems.

II. Systems of warning, caution, and indication less than adequate

Where these were necessary as a means of dealing with dangers, lack of suitable systems to ensure that they were installed and maintained properly was a causal factor of accidents (eg. warning notices, alarms, indicators etc.).
The criterion of safety inadequacy was the inadequacy of these systems.

3. Preventive Measures

I. Systems adopted for prevention less than adequate
In the case of certain construction activities, it was found necessary to adopt a proper system of work to ensure that hazards do not arise out of those activities (eg. a system to ensure that material did not collect in unwanted places, a system to ensure that preventive maintenance was carried out on certain equipment etc.). Absence of adequate systems in this respect was among accident causal factors.
The criterion of safety inadequacy was the indequacy of such systems.

4. Corrective and Control Measures

I. Systems for correcting and controlling hazards less than adequate
In certain circumstances, it was found necessary to have a system to ensure that corrective and/or control measures were adopted against potential dangers (eg. systems to ensure erection of barriers at openings, wearing of personal protection etc.). Absence of or inadequacies in such systems were found to have contributed to the occurrence of accidents.
The criterion of safety inadequacy was inadequacy in corrective/control systems.

5. Ameliorative Emergency Measures

I. Systems for emergency functions less than adequate (post-accident)

In the cases where these functions (eg. escape, rescue, fire-fighting) were likely to be necessary because of the likelihood of accidents, it was found necessary to have an appropriate system to ensure that those functions were carried out properly, if the need arose. The inadequacy of such systems had been cited as contributory factors in aggravating the consequences of accidents.

The criterion of safety inadequacy was inadequacy in systems for emergency functions.

II. Systems to ensure first aid and emergency medical care less than adequate

Lack of proper systems to ensure that, in the event of an accident, the victims receive proper first aid and medical care was a causal factor in increasing the degree of injury or other health disorder.

The criterion of safety inadequacy was inadequacy in systems to ensure that such first aid and medical care were provided without delay.

Summing Up

It is abundantly clear from the descriptions of the accident symptoms, that whether a particular condition represented a safety inadequacy or not depended upon a large number of other factors present in the particular situation. A degree of evaluation and judgement which would take those other factors into consideration was almost always involved. The outcome of the evaluation and judgement depended upon which of the

factors were taken into consideration and what degree of priority and importance was allocated to them.
The list of accident symptoms in Table 5 was used as an instrument for guiding and directing attention to the safety inadequacies in a construction site. They were general descriptions of situational factors which had meaning only in the context of a particular situation. It was useful for scanning the wide range of safety inadequacies in a site, thereby avoiding the tunnel vision and limitation of attention only to a particular type of accident symptom.

CHAPTER 7

SITE INVESTIGATION

- PART 2 OF THE STUDY -

7.1 Introduction

As discussed in Chapter 5, the approach used for the site investigations was a problem-centred one. Safety inadequacies highlighted by the list of accident symptoms were used as the problems, or critical safety elements on the site. Their presence in the site represented failure to achieve the necessary degree of safety, and each such case was an indication that some action was required. Maintaining a site free of accident symptoms was considered the overall safety objective of any site organisation. Each accident symptom on the site, being a failure to achieve that objective, was therefore used as a critical incident to form the central stimulus for the interviews.

7.2 The Study Sample

The main aim of this investigation was to generate relevant information on the basis of the developed model pertaining to each supervisor/site unit in the study sample. An attempt was made to include supervisors from as wide a range of backgrounds, working in as wide a range of categories of work sites as possible. Tables 6-9 give the range of supervisory backgrounds according to the following categories.

I. Trade or other background prior to being a supervisor - Table 6.

II. Age of supervisor - Table 7.

III. Construction experience of the supervisor - Table 8.

IV. Supervisory experience of the supervisor - Table 9.

Tables 10 to 16 give the range of work sites according to the following categories and the number of supervisors according to each type of site.

I. Type of construction as categorised in section 2.2 -

Table 10.

II. Size of firms, indicated by the number of persons employed - Table 11.

III. Size of site, indicated by the estimated value - Table 12.

IV. Stage of construction, indicated by the completed percentage of the total estimated duration of the project - Table 13.

V. Position of supervisor - Table 14.

VI. Type of contract - Table 15.

VII. Type of support staff - Table 16.

The supervisors were not given prior knowledge of the date and time of the researcher's visit or the nature of the investigation. The accident symptom occurrences used in the interview were the ones found to be present in the respective sites at the time of the visit. They could therefore be considered a random sample within the supervisor/site units selected for the study. The distribution of the numbers of accident symptom occurrences according to the table of accident symptoms developed in the first part of the study (table 5) is given in Table 17.

TABLE 6

Distribution of Supervisors According to Their Original Trade or Other Background

Trade or Other Background	Number of Supervisors
Carpentry and Joinery	26
Bricklaying and Tile Setting	17
Plastering, Cement Finishing & Terrazo Working	4
Painting and Decorating	8.
Plumbing, Gas Fitting, Heating & Ventilation	4
Improved Labourer	6
Directly Recruited with Technical Qualifications	5

TABLE 7

Distribution of Supervisors According to Ranges of Age	
Age - years	Number of Supervisors
Less than 30	6
30 to 39	16
40 to 49	22
50 to 59	18
60 and over	8

TABLE 8

Distribution of Supervisors According to Ranges of Total Construction Experience

Total Construction Experience Years	Number of Supervisors
Less than 10	3
10 to 19	14
20 to 29	22
30 to 39	20
40 - 49	9
50 and over	2

TABLE 9

Distribution of Supervisors According to Ranges of Supervisory Experience	
Supervisory Experience Years	Number of Supervisors
Less than 1	6
1 to 4	9
5 to 9	12
10 to 14	18
15 to 19	16
20 and over	9

TABLE 10

Distribution of Supervisors According to Number of Sites in Different Types of Construction

Type of Construction	Number of Sites	Number of Supervisors
New Dwelling Construction	15	20
New Public and Commericial Building Construction	14	19
New Industrial Construction	4	9
New Works of Civil Engineering Construction	8	12
Repairs, Maintenance, Conversions, Improvements etc. of Existing Structures of Above Types	9	10

TABLE 11

Distribution of Supervisors and Sites According to Total Numbers Employed in Firms

Total Number Employed in the Firm	Number of Firms	Number of Sites	Number of Supervisors
1 to 24	3	6	8
25 - 114	3	13	17
115 - 1,199	5	22	31
1200 and above	2	9	14

TABLE 12

Distribution of Supervisors and Sites
According to Total Estimated Value of the Project

Estimated Project Value £	Number of Sites	Number of Supervisors
Less than 100,000	9	9
100,000 to 199,999	15	17
200,000 to 499,999	11	14
500,000 to 999,999	9	14
1 million and over	6	16

TABLE 13

Distribution of Supervisors and Sites
According to Completed Percentage of Project Duration

Range of Completed Percentage	Number of Sites	Number of Supervisors
0 to 20%	10	13
21 to 40%	12	18
41 to 60%	15	21
61 to 80%	7	11
Over 80%	6	7

TABLE 14

Distribution of Supervisors
According to the Position of Supervisor

Position of Supervisor	Number of Sites	Number of Supervisors
Supervisor In charge of the Site	32	32
Supervisor In charge of a Section	9	18
Supervisor In charge of a Trade	6	14
Semi-supervisor (Ganger, Section leader, Chargehand)	3	6

TABLE 15

Distribution of Supervisors
According to the Type of Contract

Type of Contract	Number of Sites	Number of Supervisors
Bill of Quantities & Schedule of Rates Contract	29	40
Lump-sum Contract	10	13
Re-imbursable Cost Contract	7	12
Direct Labour Contract	4	5

TABLE 16

Distribution of Supervisors
According to the Type of Support Staff on Site

Type of Support Staff	Number of Sites	Number of Supervisors
Safety Officer and Superior on Site	3	7
Superior on Site but not Safety Officer	15	31
Neither superior nor Safety Officer on Site	26	26
Visiting Supervisor (only workmen on site)	6	6

A.S.O. Accident Symptom Occurrences

TABLE 17

Distribution of Accident Symptom Occurrences According to Accident Symptoms

Category of Accident Symptoms	Worksetting	No. of A.S.O	Provision	No. of A.S.O	Personnel	No. of A.S.O	System of Work	No. of A.S.O
1. Inadequacies of the resources and procedures used for the operations	i. Lack of Stability	31	i. Lack of Quality and Quantity	11	i. Lack of Ability of the Personnel	6	i. Systems of Manual Handling Unsuitable	12
	ii. Unsuitable Construction and Condition	26	ii. Lack of Fitness	8	ii. Persons Using Unsound and/or Unsuitable Construction Items	18	ii. System of Mechanical Handling Unsuitable	4
	iii. Unsuitable Loading	19	iii. Lack of Suitability	6	iii. Persons Using Inappropriate Methods and Techniques	15	iii. System of Transport Unsuitable	9
	iv. Improper Positioning of People and Objects	35	iv. Harmful Construction material	13	iv. Persons Conducting Themselves in an Improper Manner	5	iv. System of Movement and Placement of Personnel and Objects Unsuitable	3
	v. Improper stacking and Storing of Objects	18	v. Harmful Construction Equipment Machinery and Tools	8	v. Presence of the Public and Other More Vulnerable Personnel	8	v. System of Operations Unsuitable	10
	vi. Accessible Edges and Openings	22						
	vii. Protruding Objects	30						
	viii. Obstructions	24						
	ix. Flying and Falling Objects	14						

continued...

A.S.O. - Accident Symptom Occurrences

TABLE 17 continued

Category of Accident Symptoms	Worksetting	No. of A.S.O.	Provision	No. of A.S.O.	Personnel	No. of A.S.O.	System of Work	No. of A.S.O.
	x. Harmful Agents in the Atmosphere	8						
	xi. Harmful Materials	7						
	xii. Improper Supply and Service Lines	3						
	xiii. Inappropriate Site Layout	16						
	xiv. Inadequate visibility	9						
	xv. Proximity to and Accessibility by the Public	7						
2. Inadequacies of the Diagnostic and/or Hazard Detection Measures Necessary	i. Location of Persons and Equipment to Diagnose, Detect and Monitor Hazards Less Than Adequate	10	i. Facilities Provided for the Purpose of Diagnosing Detecting and Monitoring Hazards Less Than Adequate	14	i. Persons Assigned with the Functions of Diagnosing Detecting and Monitoring Hazards Less Than Adequate	16	i. System of Diagnosing and Monitoring Hazards, Less Than Adequate	8

A.S.O. - Accident Symptom Occurrences

TABLE 17 continued

Category of Accident Symptoms	Worksetting	No. of A.S.O.	Provision	No. of A.S.O.	Personnel	No. of A.S.O.	System of Work	No. of A.S.O.
2. Inadequacies of the Diagnostic and/or Hazard Detection Measures Necessary	ii. Location and Condition of Warnings, Cautions and Hazard Indicators Less Than Adequate	12	ii. Facilities for the Purposes of Warnings, Cautions and Indicators, Less Than Adequate	6	ii. Persons Failing to Obey the Warnings. Cautions and Indicators	4	ii. Systems of Warning, Caution and Indication Less Than Adequate	6
3. Inadequacies of the Preventive Measures	i. Location of the Facilities and Personnel Engaged in the Preventive Functions Less Than Adequate	20	i. Facilities Provided for Preventive Purposes Less Than Adequate	7	i. Personnel Engaged in Preventive Functions Less Than Competent	11	i. Systems of Adopting Preventive Measures Less Than Adequate	13
4. Inadequacies of the Corrective and Control Measures	i. Location, Construction and Condition of the Corrective and Control Measures Less Than Adequate	15	i. Facilities Provided for Corrective and Control Functions Less Than Adequate	10	i. Persons Failing to Adopt Corrective and Control Measures and Use Those Facilities	14	i. Systems Adopted for Corrective/ Control Measures Less Than Adequate	12

Continued...

A.S.O. - Accident Symptom Occurrences

TABLE 17 continued

Category of Accident Symptoms	Worksetting	No. of A.S.O.	Provision	No. of A.S.O.	Personnel	No. of A.S.O.	System of Work	No. of A.S.O.
5. Inadequacies of the Ameliorative and Emergency Measures	i. Location and Layout of Escape, Rescue and Fire Fighting Arrangements Less Than Adequate	10	i. Facilities for Escape and Fire Fighting Less Than Adequate	5	i. Ability of Personnel in Escape, Rescue and Fire Fighting Activites Less Than Adequate	9	i. Systems of Escape, Rescue and Fire Fighting Less Thank Adequate	8
	ii. Location of First Aid and Emergency Medical Care Less Than Adequate	6	ii. Facilities for First Aid and Emergency Medical Care Less Than Adequate	9	ii. Competence of Personnel in First Aid and Emergency Medical Care Less Than Adequate	21		
6. Inadequacy of Other Relevant Measures	i. Location of Welfare Facilities Less Than Adequate	5	i. Quality and Quantity of Welfare Facilities Less Than Adequate	3				
		347		100		127		85

It was not possible to verify whether the sample of supervisor/work site units used was strictly representative. However, their distribution over a large range of categories as indicated in the above tables, and the randomness of the selection of accident symptom occurrences within them was considered to have generated information relating to the total range of types of situations, and hence to be sufficiently comprehensive for the purpose of an exploratory descriptive study. The main conclusions are drawn from the total content of information by highlighting the influencing factors perceived. A subsidiary analysis is made by the variables studied to explore any possible trends. The results of this research, therefore, primarily provide an adequate general description of the total field and a demonstration of the applicability of the method and techniques over its whole range.

7.3 The Field Study

The field study essentially took the following steps. The head office of the construction firm was first contacted for permission to use one or more of their sites in the investigation. Often, an interview with a manager or a safety officer was found necessary for this purpose. In the cases where permission was granted, the firm would inform the site concerned of this fact. On visiting the site, and meeting the supervisor, it was fist necessary to explain to him some details of the study. The picture presented of the researcher was that of a student collecting information regarding safety aspects of construction supervision in order to prepare a report to be submitted to the university. The assurance was given that the information would not be used for any other purpose and that the identity of the supervisor would not be divulged in the report. With the help of other relevant conversation, it was invariably possible by this stage to build up rapport with the supervisor. He was made to understand, that by helping in the exercise, he was aiding the researcher to gather detailed information on certain aspects of his work. At no stage of the interview was the supervisor made to feel that he was the subject of study, or that he was being personally assessed in any sense.

The supervisor first had the full meaning of an accident symptom and the lists of accident symptoms explained to him and was told that the researcher would like to get some specific details of those existing in the site. The supervisor and the researcher then went round the site looking for accident symptoms. The lists were used to enable the supervisor to pick them out even in a situation where large numbers of activities were in progress. Once an accident symptom was noted (pointed out by the supervisor, or if he failed to do so, pointed out by the researcher), then the supervisor was questioned on it according to the guidelines of the flowchart in figure 3. Throughout the interview, the researcher played the role of a student asking questions and the supervisors were found to fall readily into the role of doing their best to provide answers. Notes were taken down on a field book of all the details of the interview whilst it was in progress. Tape recording of interviews was rejected for a number of reasons, such as, the practical difficulty of recording on a busy, noisy site, in the open air and the likelihood of inhibiting the supervisors' responses.

The questions asked were not always exactly in the form indicated in the flowchart in fig 3. However, the focus of the research was maintained by getting the answers to those questions in an indirect manner by a number of informal questions which were found to be suitable in the circumstances. For example in connection with a section of the area of supervision, one of the first questions asked of the supervisor would be,

"Are there any accident symptoms in this section?"

or "What are the safety inadequacies in this section?"

or "Can you identify any accident symptoms in this plant?"

If the supervisor was not able to identify any accident symptoms that the researcher noticed, he would be specifically questioned on it by a probe such as,

"What do you think of......?"

The answer perhaps would be one of the following.

"I never thought of that as an accident symptom but I suppose you can call it one"

or "Yes it is an accident symptom" and he would explain why he missed it.

or "I do not think that it can be called an accident symptom" and then he would sometimes explain the reasons.

If it was a response of the last kind the researcher described to him how it would constitute an accident symptom, whereupon he would either agree, or explain why he would not agree.

In this manner the flowchart in fig 3 would be completed in sequence, step by step, with respect to as many accident symptoms in the site as was possible within the time allowed.

Due to the large variation in size of area and nature of activities between different supervisory sections, limiting the interview to a standard duration would not have been useful, and hence was not attempted. Also, since the supervisors did not have prior knowledge of the date and time of the researcher's visit, the time that they could allocate for the interview was limited by circumstantial factors. The duration of site interviews therefore varied from a minimum of 1 hour to a maximum of 4 hours.

It was not possible in this study to make sure that all the accident symptom occurrences present on the supervisor's section during the visit were used in the investigation. Therefore the number of accident symptom occurrences recorded did not provide an adequate measure of the safety level of the section. However, the total accident symptom occurrences present on a site at any particular time, if counted, would no doubt provide a very good measure of its safety at that time.

Apparently, supervisors were happy to discuss each accident symptom in detail with someone who seemed to understand their views and took a great deal of interest in what they had to say. None of the supervisors gave the impression that he wanted to get it over with quickly and get rid of the researcher as early as possible.

The study was carried out during a period when there was much concern and interest about safety in industry as a result of the new Health and Safety at Work Act (1974). Undoubtedly this would have contributed to the high degree of co-operation received from the firms and supervisors. The fact that the interview of each supervisor was a one-off occurrence and lasted only a limited duration also would have helped to keep the interest of the subjects throughout each interview.

As pointed out by Moser and Kaltan (1971) participant observation and focussed interviewing are techniques which are highly dependent on the individual investigator. Their success depends much upon the skill and ability of the researcher and his acceptability to the subjects. There are many research studies in sociology, where the researchers have taken advantage of their past experiences and unique expertise to provide a wealth of insight and knowledge on a wide range of topics. Examples are the studies of Caplow and McGee (1958) on academicians, and Becker (1951, 1963) on Jazz Musicians. They used their 'inside' thorough knowledge of the research area extensively in the studies.

The present researcher's background (in gaining a BSc degree in Civil Engineering, full Membership of the Institution of Civil Engineers and an MSc degree in Occupational Safety and Hygiene with experience in working as a Civil Engineer and a Factory Inspector specially dealing with the construction industry) together with the studies on construction accident reports, which formed the early stages of this research was of paramount assistance in gaining entry into the research setting, in being fully aware of what to expect and in how to handle it correctly. It also facilitated rapport with the supervisors. Identification of accident symptoms in the sites and conducting a focussed interview on these symptoms also required much knowledge and expertise on construction works and their safety.

Another advantage of this technique was the proximity of the researcher to the data he was gathering. It facilitated investigation in depth and also gave an objective set of data by providing a practical and real life situation for the supervisors to refer to. They were able to talk about situations and physical surroundings that were right in front of them, and the researcher was able to check the majority of the responses and elicit further information by asking probe questions.

Construction sites are dangerous places, which need a certain degree of experience in order to move about freely and carry out studies in them. A non-construction man is likely to need a lot more explanation of what is going on, thus becoming a greater source of disturbance. Construction supervisors being most of the time tied up with pressing work, would be less tolerant of having to disrupt their own job and pay full attention to the researcher. On the other hand, they would be more likely to discuss freely and accurately with another member of the industry, who had a good understanding of the setting. Therefore, the researcher personally, and the research technique adopted (where undisturbed continuous attention of the supervisor was not essential) made it much easier to get into the research setting and to overcome many problems which may have otherwise arisen during the course of this study.

7.4 Presentation of Site Interview Data in Part 2 of the Study

Site interview data were categorised into 2 types. Type 1 consists of the distribution of the numbers of accident symptom occurrences on each line of the flowchart of the interview sequence. Type 2 consists of the data concerning explanatory reasons indicated in the case of each 'NO' answer.

7.4.1 Numbers of Accident Symptom Occurrences following each Flowline (Type 1)

Data on the distribution of accident symptom occurrences following different flowlines of the interview sequence are presented on the flowchart itself (figs. 4 to 8). The legend to the flowchart appears immediately after fig. 8 on page 196 to facilitate easy reference. Figure 4 gives the overall numbers of accident symptom occurrences following each flowline. Figures 5, 6, 7 and 8 give the corresponding number of accident symptom occurrences in work setting, provision, personnel and system of work respectively.

Altogether 15 different flowpaths were found in the flowchart. In the interview sequence, any particular accident symptom occurrence could follow only one of these. Table 18 gives the distribution of the numbers of accident symptom occurrences according to these flowpaths.

Overall Numbers of Accident Symptom Occurrences

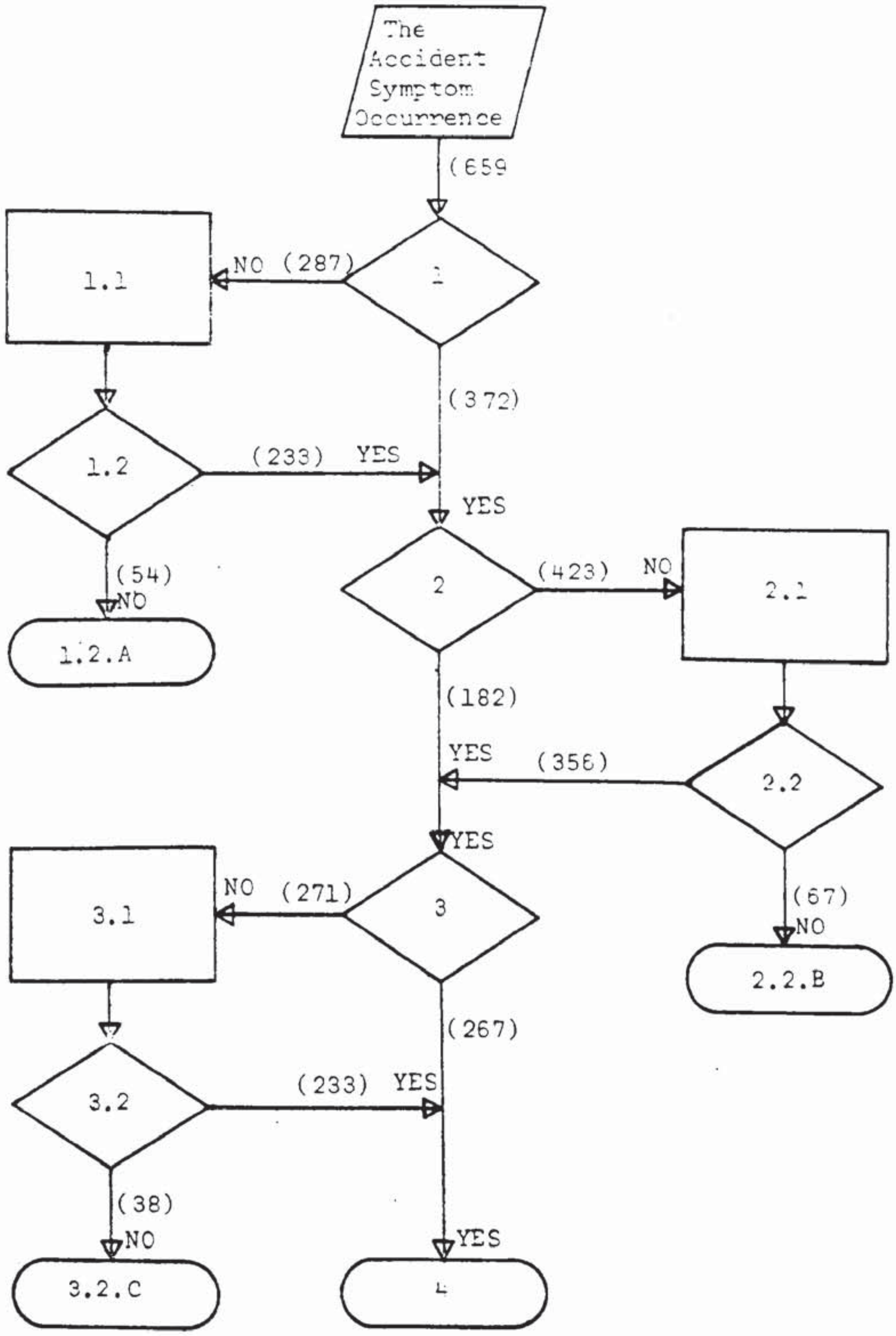

Fig. 4

The legend to this flowchart appears on page 196

Numbers of Work Setting Accident Symptom Occurrences

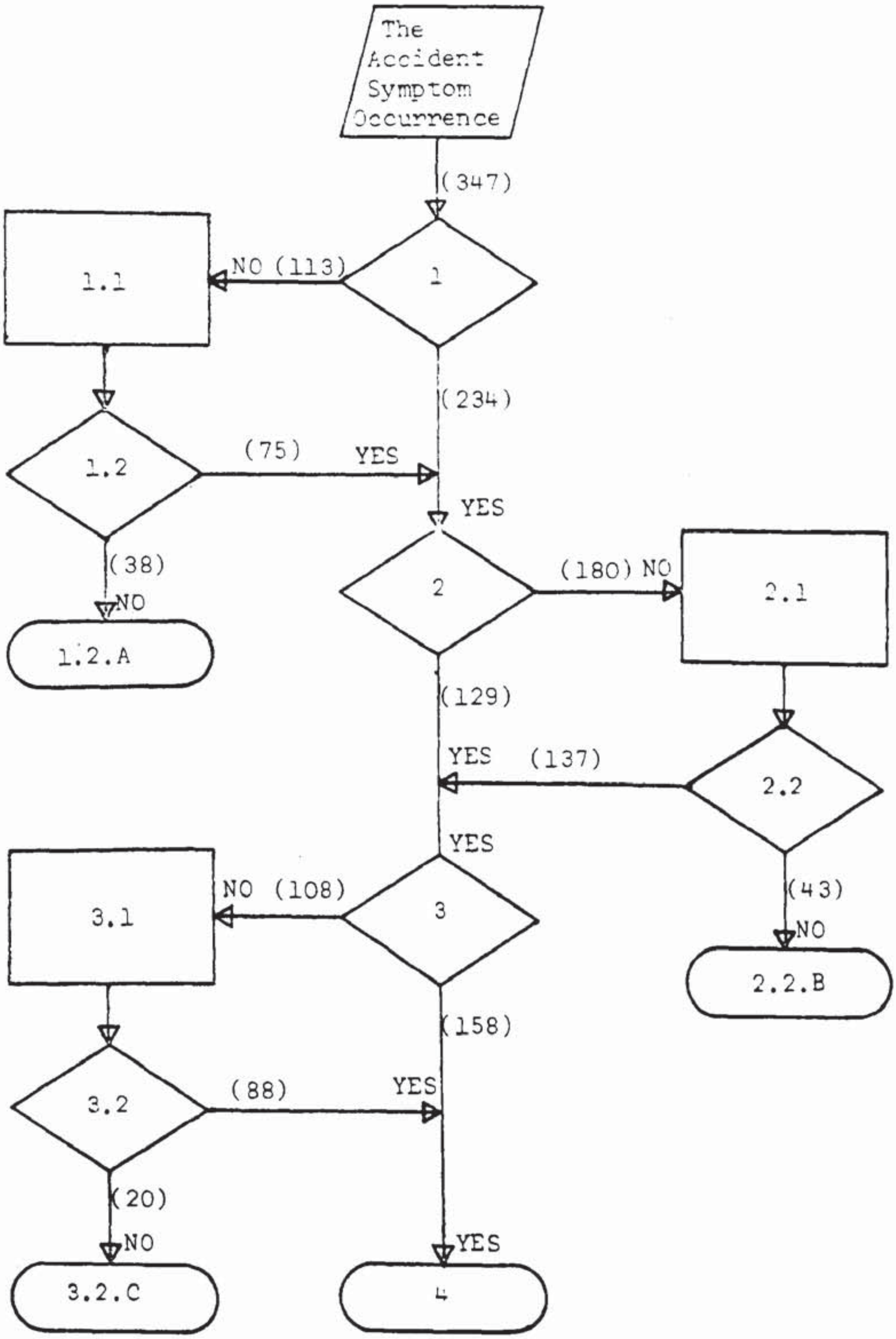

Fig. 5

The legend to this flowchart appears on page 196

Numbers of Provision Accident Symptom Occurrences

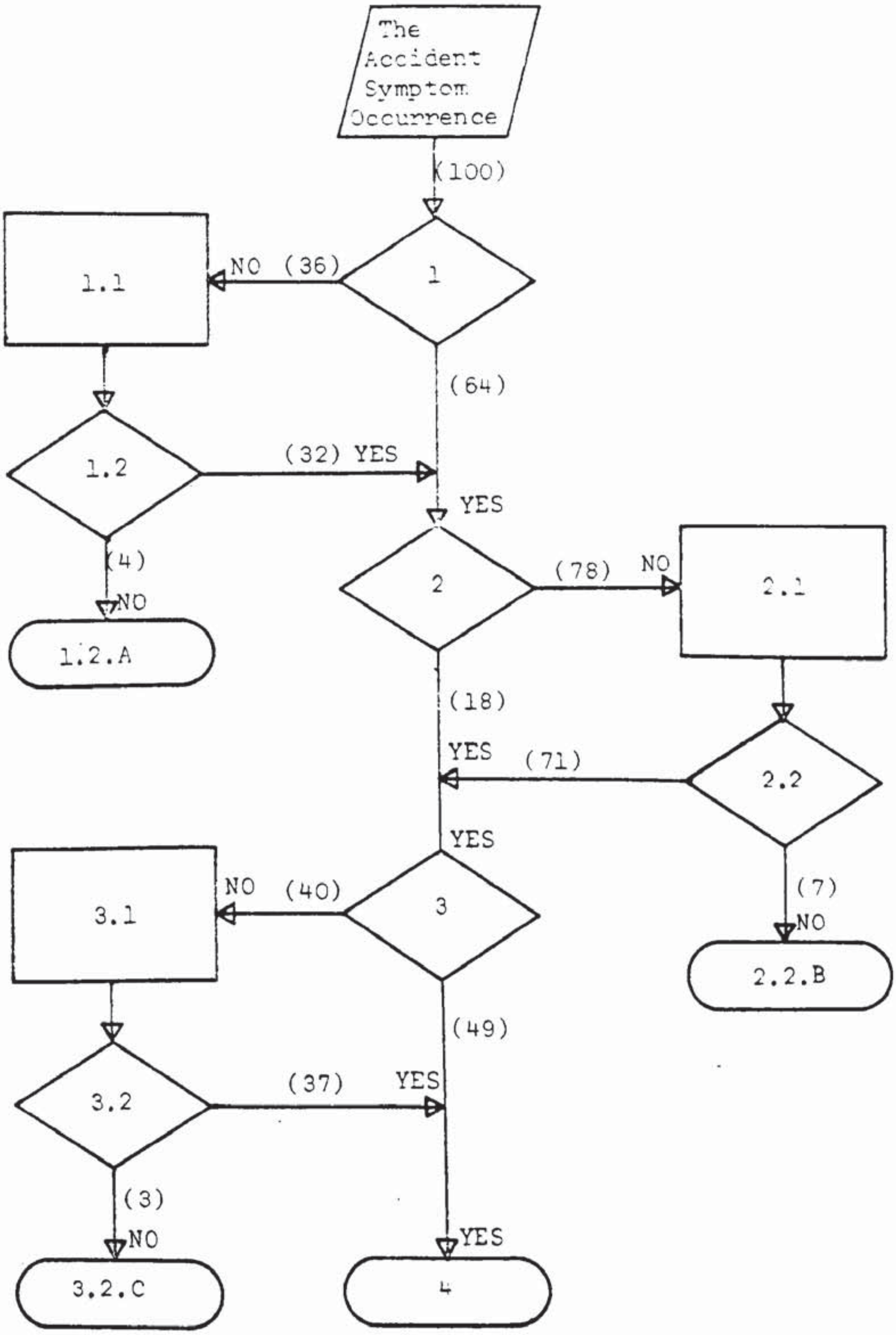

Fig.6

The legend to this flowchart appears on page 196

Numbers of Personnel Accident Symptom Occurrences

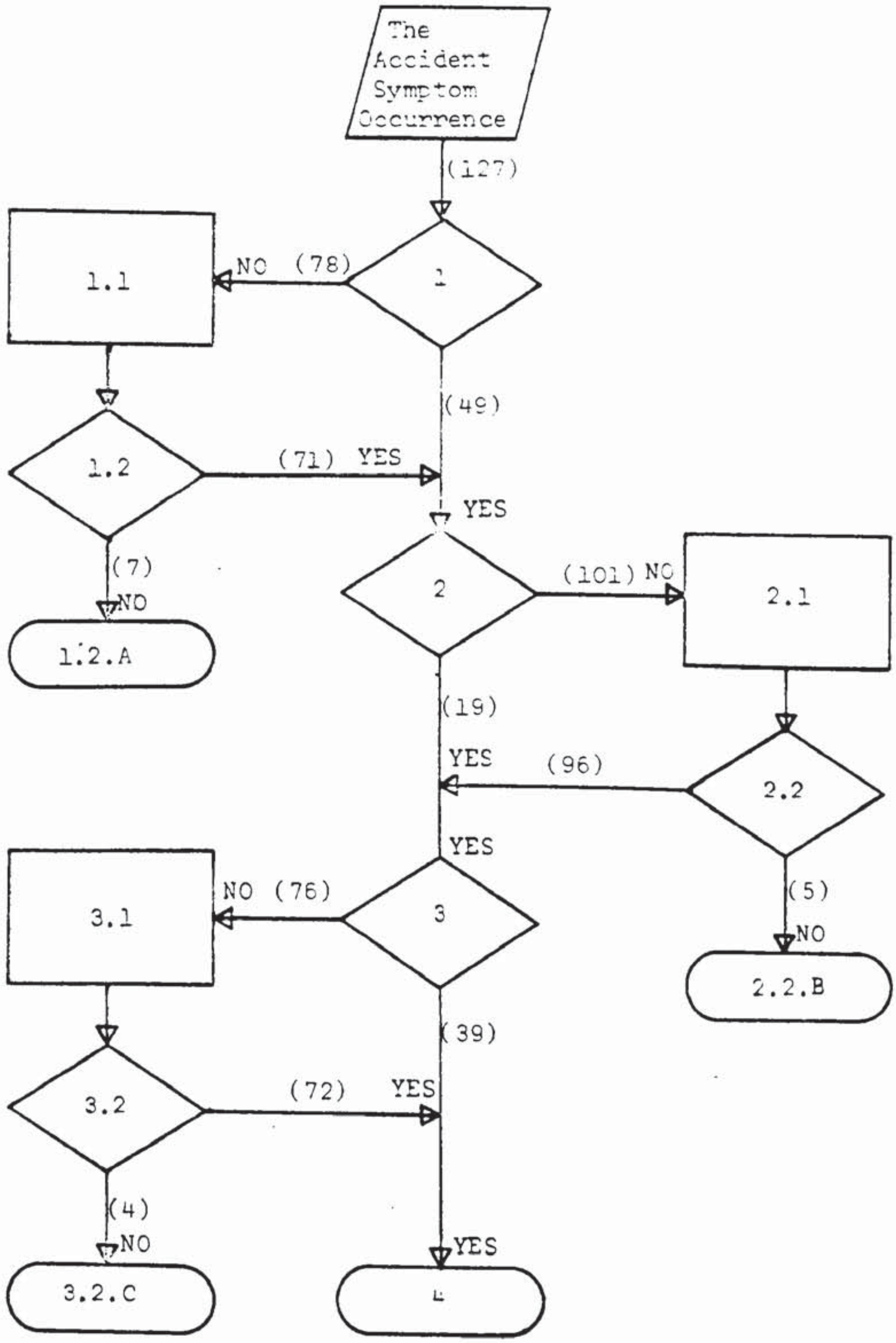

Fig. 7

The legend to this flowchart appears on page 196

Numbers of System of Work Accident Symptom Occurrences

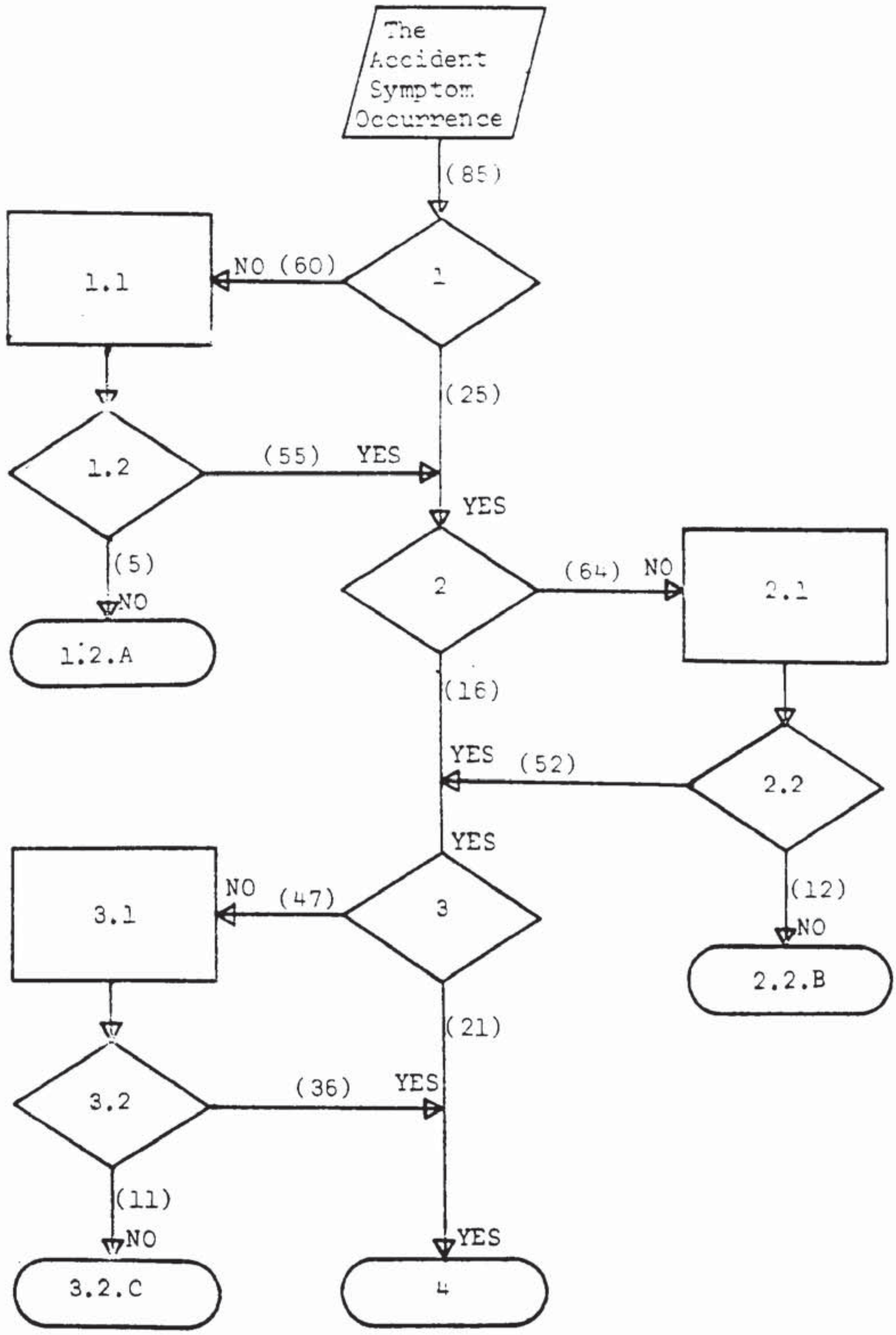

Fig. 8

The legend to this flowchart appears on page 196

Legend to the flowchart

1. Did the supervisor recognize the accident symptom occurrence by himself?

1.1 Reasons for answering NO to 1

1.2 Did the supervisor agree that it was an accident symptom occurrence when pointed out?

1.2.A Reasons for answering NO to 1.2

2. Did the supervisor think that he should deal with the accident symptom occurence?

2.1 Reasons for answering NO to 2

2.2 Did the supervisor agree that the accident symptom occurrence should be dealt with by somebody?

2.2.B Reasons for answering NO to 2.2

3. Did the supervisor know a suitable method of dealing with the accident symptom occurrence?

3.1 Reasons for answering NO to 3

3.2 Was a suitable method agreed upon by the supervisor and the researcher?

3.2.C Reasons for answering NO to 3.2

4. Any reasons not given above for the presence of the accident symptom occurrence.

TABLE 18

Distribution of Accident Symptom Occurrences According to Each Flowpath (page 128)

The Flowpath	Work Setting	Provision	Personnel	Systems of Work	Overall
1. 1 → 1.1 → 1.2 → 1.2.A.	38	4	7	5	54
2. 1 → 1.1 → 1.2 → 2 → 2.1 → 2.2 → 2.2.B.	31	5	4	9	49
3. 1 → 2 → 2.1 → 2.2 → 2.2.B.	12	2	1	3	18
4. 1 → 1.1 → 1.2 → 2 → 3 → 3.1 → 3.2 → 3.2.C.	9	2	3	6	20
5. 1 → 2 → 2.1 → 2.2 → 3 → 3.1 → 3.2 → 3.2.C.	3	1	0	1	5
6. 1 → 1.1 → 1.2 → 2 → 3 → 3.1 → 3.2 → 3.2.C.	6	0	1	3	10
7. 1 → 2 → 3 → 3.1 → 3.2 → 3.2.C.	2	0	0	1	3
8. 1 → 1.1 → 1.2 → 2 → 2.1 → 2.2 → 3 → 3.1 → 3.2 → 3.2.C.	20	11	36	27	94
9. 1 → 1.1 → 1.2 → 2 → 2.1 → 2.2 → 3 → 4	2	8	17	5	32
10. 1 → 1.1 → 1.2 → 2 → 3 → 3.1 → 3.2 → 4	4	5	6	4	19

continued...

TABLE 18 continued

The Flowpath	Work Setting	Provision	Personnel	Systems of Work	Overall
11. 1 → 1.1 → 1.2 → 2 → 3 → 4	3	1	4	1	9
12. 1 → 2 → 2.1 → 2.2 → 3 → 3.1 → 3.2 → 4	54	17	27	4	102
13. 1 → 2 → 2.1 → 2.2 → 3 → 4	49	32	13	9	103
14. 1 → 2 → 3 → 3.1 3.2 → 4	10	4	3	1	18
15. 1 → 2 → 3 → 4	104	8	5	6	123

7.4.2 Explanatory Reasons for Each 'NO' Answer (Type 2)

This section presents the data on the factors influencing different stages of the decision process in the flowchart. A major part of this data was descriptive, and therefore had to be classified into a systematic form for the purpose of presentation, interpretation and analysis. Explanatory reasons indicated in the case of each 'NO' answer were categorised as factors influencing that decision. The technique used in categorising the reasons into factors was similar to that used for deriving accident symptoms from accident causal factors. The early reasons were stated in a general form as factors, and the rest of the reasons were either categorised under those factors or formed new ones. When no new factors had appeared for the last 25 supervisor/site units (on 258 accident symptom occurrences), this was considered a criterion for terminating data collection. The number 25 was considered reasonable in view of the nature of the study and the limitations of the available time and resources.

A total of 15 factors were derived by the above procedure. These factors were found to be highly interdependent and interrelated. Therefore in some cases there is a degree of overlap. Also, the classification cannot be said to be a mutually exclusive one. A short description of each such factor and the type of reasons, categorised under it, is given in the following.

1 Resource Limitations

Limitations of the resources (personnel, material, equipment, space etc.) made available to the supervisory section for carrying out the expected works were categorised under this heading. Supervisors claimed that in many cases, they had to

work with limited resources. They blamed this on the "incompetence" or "deliberate bungling" of many parties. Senior management, supplies and maintenance departments, materials and plant suppliers are some examples.
The following types of reasons were incorporated in this category

a) The senior management had not provided sufficient and/or suitable resources
b) The suppliers had not supplied sufficient and/or suitable resources
c) The sub-contractors had not brought in sufficient and/or suitable resources
d) The supervisor could not obtain sufficient and/or suitable resources because of their scarcity
e) The supervisor could not obtain sufficient and/or suitable resources because insufficient money had been allocated for these purposes
f) Provisions which had become defective in the site were not repaired or replaced without delay
g) Personnel who were found unsuitable or undesirable in the site had not been replaced without delay
h) The need for a certain type of resource was discovered rather too late
i) The job requirements (type of work, rate of work, etc.) changed during the progress of work, and adequate resources could not be obtained without delay

2. <u>Outside the Boundaries of Supervisory Duties</u>

The cases where the supervisor considered that the activities concerned were outside his duties, according to the way the distribution of responsibilities in the site was perceived by him, were categorized under this heading. In a majority of them, fixed or clearly expressed responsibilities for ensuring safety in the workplace were found to be absent. On the other hand, production responsibilities had been clearly defined. Supervisors passed over many safety functions which had not been specifically stated as theirs, to other parties, such as safety officers, senior managers, sub-contractors, workmen, suppliers, maintenance departments etc. In certain cases where the safety responsibilities had been clearly stated, supervisors were found to interpret the context and limit the extent of such responsibilities to a manageable form.

The following types of reasons were grouped under this category

a) The duties had been clearly defined as someone else's or as non-supervisory

b) The duties had not been clearly defined by the organisation but were attributed to someone else, such as, the safety officer, specialists, senior management, plant suppliers, sub-contractors, maintenance gangs, etc. by the supervisor

c) The cases of undefined duties which were not accepted by the supervisors, even though they were not attributed to anyone else

d) The cases where supervisors accepted responsibility only to a limited extent, eg. They limited the responsibility to just telling the workmen to attend to certain safety requirements and left the decision of whether to do so or not to the workmen.

3. <u>Incompatible Demands</u>

This category refers to the cases where supervisors were called upon to meet demands which required separate and irreconcilable courses of action. Supervisors were found to lower the expected safety level or neglect safety requirements altogether, when they came into conflict with other work demands which were considered more important at the time. Production goals which were clearly defined and for which they were held accountable, often received a higher priority than keeping the site free of accident symptoms. Apart from demands concerning economic and output aspects of the work, the values and expectations of different parties involved with the work activities were also sometimes incompatible with those of the supervisors. In many such cases, supervisors were found to surrender their expectations and revise their goal priorities in order to maintain good relations.

The types of reasons incorporated in this category were those where maintaining an accident symptom free workplace was in conflict with,

a) achieving the desired rate of progress of work
b) achieving the desired quality of work (i.e. accuracy and good workmanship)
c) completing the job within the estimated sum of money
d) continuing work progress with the limited resources available
e) achieving the necessary degree of co-ordination between different work groups
f) maintaining a good working relationship with the workpeople and /or supervisors
g) successful socialization in his new workplace
h) achieving other miscellaneous work demands .

4. Acceptance of Hazards as Inevitable

The cases where supervisors considered that the accident symptoms were an unavoidable characteristic of the construction industry, were grouped under this category. They included beliefs that the industry was dangerous by nature and that those accident symptoms represented the natural and inevitable state of the industry.

The following types of supervisory statements were incorporated in this category

a) "Construction is a hazardous industry. Therefore some accident symptoms are inevitable"
b) "In order to do most types of work in this industry, it is essential to take some risks"
c) The conditions and activities are "natural characteristics of this industry". Therefore, "although they may be considered unsafe in other situations, they should not be considered so in this industry"
d) If attempts were made to prevent those conditions or activities "it would not be possible to get much work done. Therefore, in the construction industry they are not accident symptoms"

5. Influences of the Social Climate

Supervisory actions were found to be influenced in many ways by the degree to which they were acceptable to workpeople in the particular social climate of the workplace. In construction operations, social organisation and co-ordination between activities were found to be maintained primarily through negotiation and agreement between different parties involved. As the main co-ordinator of the works within his area of supervision, the supervisor was found to feel the need to maintain good relations with and between different work groups and other categories of personnel involved, for the successful discharge of his duties. As a result, the supervisor's informal role as expected by and acceptable to his work associates made it necessary for him to neglect some accident symptom occurrences which he was formally expected to deal with.

The following types of influences were grouped under this category

a) Workpeople choose to take risks for their own convenience/ benefit. The supervisor did not like to cause displeasure by attempting to stop them from doing so

b) When some sub-contractors, or workgroups upon which the supervisor had no authority, maintained a low level of safety, he could not impose stricter conditions on others

c) When the supervisor joined a site already in progress he could not risk controversy with people by attempting to deal with some accident symptoms

d) When the supervisor was subject to strong pressure by the workpeople against actions necessary to prevent accident symptoms in the workplace, it restricted his supervisory capabilities

e) When the relationship between the supervisor and some workmen (eg. skilled personnel, certain sub-contractors) was such that the supervisor did not interfere with their operations, supervisory actions with regard to accident symptoms in their activities were restricted.

6. Tradition in the Industry

In the construction industry, traditional practices have been developed over a long period, and form the main foundation upon which the working of the industry is built. They exercise a powerful influence upon the individuals in the industry to comply. Supervisors, who invariably had a long service in the industry, being introduced, experienced and socilaized within the industry, were found to be ardent followers of established tradition. Being an integral part of their 'experience' in the industry, certain accident symptom conditions which formed a part of tradition in the industry were acceptable to them.

The following types of reasons were incorporated in this category

a) Accident symptoms which were a part of the way things were being done according to established traditional practice were not perceived as accident symptoms by the supervisor
b) Actions necessary to deal with the accident symptom involved changing the traditional ways of work. This was not acceptable to the supervisor, his superiors and/or the workpeople
c) Supervisory actions necessary to get the workpeople to deal with the accident symptoms were against established traditional practice.

7. Lack of Technical Competence

The cases where supervisors did not possess the knowledge, skill and/or ability to cope with the demands of the work situation were grouped under this category. The gaps in competence, identified were found to be of the following types

i Lack of clear awareness and ability to implement the safety provisions which should be incorporated in the specific areas, eg. safety features of scaffoldings, excavations, blasting operations etc.

ii Lack of clear awareness of and ability to deal with the safety of the technical aspects of operations,for example, lifting and erection of heavy structural components needed to be carried out according to technically adequate methods and systems, if accidents were to be avoided

iii Lack of ability to make a satisfactory evaluation of the safety aspects of interactions between areas, operations and activities. For example, demolition operations and adjacent structures, movement of heavy vehicles near excavation edges, etc..

Types of reasons incorporated in this category were as follows

a) The supervisor was not knowledgeable and/or skilled in the type of work

b) The supervisor was not familiar with the hazards involved in the particular activities

c) The supervisor lacked understanding and awareness of the hazard control measures necessary to be adopted in the particular case

d) The supervisor did not have the competence to carry out some specific safety duties he was prescribed to perform, eg. inspecting scaffolds and excavations

e) The supervisor understood the hazards and the standards to be achieved in prevention and control, but lacked the knowledge and ability technically and/or managerially to implement them effectively

f) The supervisor had misunderstood, or lacked understanding of the safety standards and regulations applicable in the situation

g) When the men in a specialist job were not able to or did not deal with the hazards, the supervisor himself was not competent to recognise or deal with them.

8. Dependence Upon the Individual Workmen

The cases where supervisors regarded the skill and ability of workmen to work in the presence of hazards as a controlling factor, were grouped under this category. Ability to cope with and work in the presence of certain accident symptoms associated with their work was considered a part of the specialist competence of some sub-contractors and skilled workmen. However, in such cases it was expected that there were no other conditions which either rendered the skill and ability of the personnel ineffective in coping with them (eg. lack of vital information about other activities in and around the area of work, lack of control on vital activites and conditions in and around the area of work, other parties who have control over the work exercising their influence to cause deviations from safe practices, etc.), or which exposed non-skilled persons to those hazards. In the case of such specialist jobs, there were hazards which were outside the ones controlled by the skill and ability of the personnel employed. Supervisors were found either to fail to recognise or to ignore those hazards being erroneously perceived as belonging to the areas under the specialists' control. There were also cases where supervisors depended on the skill and ability of persons who did not have those special skills, as a hazard control measure, in general.

The following types of supervisory beliefs were incorporated in this category

a) "The men were quite capable of looking after themselves in hazardous situations"

b) "If the man could not cope with the situation, he should not be working in the construction industry"

c) "Construction workmen were a special category of people who could cope with many hazardous situations which others could not"

d) "Skilled people should be able to limit the hazards in their jobs to a level that they could cope with"

e) "In construction, each man should be given the freedom to decide how best to do his job, since the operations involved different individual tasks, by different men"

f) "In construction, each man must be allowed to decide what risks he can take according to his ability".

9. <u>Lack of Authority</u>

Construction teams were found not to be related by a standard authority structure. Many groups operated on a contractual and independent basis. Relationships were not clearly marked as superior, subordinate, or equal. The cases where supervisors perceived that they lacked authority for actions and those where they were uncertain about the authority structure of the site were grouped under this category. Construction supervisors depended largely on the actions of workers and sub-contractors to achieve their work goals. Under certain circumstances, they were also found to surrender (or feel reluctant to exercise) their authority in certain areas of work in order to maintain harmony and achieve interpersonnel agreement between different members of the organisation

The following types of reasons were incorporated in this category

a) Supervisors had no authority to interfere with the particular operations, due to contractual agreements, company rules, etc.
b) Supervisors were not certain whether they had the authority because of the lack of clarity of the authority structure in the organization and because authority varied with different groups.
c) Supervisors surrendered authority for the sake of maintaining harmony and interpersonnel agreement between members and general smooth progress of work.

10 Contingency Situations

In construction works, unexpected events were known to take place frequently, for which advanced preparation or planning had not been done (eg. bad weather, breakdown of equipment, shortage of personnel, materials and equipment, etc.). Sudden re-distribution of resources would then be made essential. Use of limited, sub-standard or unsuitable resources and techniques, or adoption of improvisations was found to be common practice in such cases. These emergency measures often fell short of adequate safety in the workplace. The following types of reasons were incorporated in this category

a) Arrival on the site when not expected and non-arrival when expected of provisions and personnel
b) Break down of equipment, plant, material etc.
c) Disputes with workpeople, suppliers, sub-contractors etc.
d) Sudden re-arrangements of personnel, provisions, operations etc..

e) The belief that, unless risks were taken, contingency situations would not be coped with

f) The strains and disruptions caused by contingency situations were believed to make people take higher risks

g) Hazards in contingency situations were often of extremely short duration, and therefore were more readily ignored

h) Contingency situations did not permit the opportunity to think through and carefully plan the operations. Emergency measures adopted in a hasty manner tended to miss out accident symptoms.

11. Safety Management System Factors

This category refers to the aspects of the system of safety management within the firm as implemented by the senior managers. It is generally accepted that the formulation of global objectives for the working of the organisation and the overall operating system are a "senior management" function. They include the systems of defining and controlling the necessary activities. Supervisory functions were found to be prescribed, controlled and limited by those management systems.

The types of reasons incorporated in this category were

a) Absence of systems to ensure that the resources and operational aspects of the site were suitable and/or sufficient

b) Absence of suitable and sufficient safety management systems such as periodic examinations, inspections, authorizations, permit to work systems, control systems, ameliorative systems etc.

c) Absence of facilities related to safety, such as first-aid, sanitary conveniences, meal rooms etc.

d) The personnel and provisions engaged to implement safety management systems unsuitable and/or insufficient

e) Communication systems regarding safety information transfer, inappropriate or less than adequate.

12. Task Overloading

The work of most supervisors was found to be highly demanding. Many felt that they were expected to carry out more tasks than they could cope with. One result of task overloading was for the supervisors to leave unattended to, those aspects of the job which they thought less important. Another effect was that they adopted a reactive approach to work, i.e. they dealt with problems which were thrown at them and had to be dealt with rather than planning ahead. Those problems which had to be sought out or taken up on their own initiative were often postponed or ignored. Under those circumstances, they tended to deal with comparatively routine problems with standard or relatively easy solutions in preference to to the more difficult or ambiguous problems.

The following types of reasons were incorporated into this category

a) Lack of time to allocate to dealing with accident symptoms because of greater pressure to attend to other duties which fill up their day.

b) Supervisors had enough problems thrown at them demanding action, without having to look for accident symptoms

c) Certain operations or activities which needed closer supervision (because of the nature of the hazards or the lack of experience of men) did not get such supervision because of the high level of work

d) Certain safety checks, inspections, and monitoring functions were not carried out because of the lack of time to do them

e) What was necessary to deal with the accident symptom was far too complicated and needed much more time than he could afford

f) Supervisors had no time to familiarise themselves with the information necessary to deal with the hazard.

13. Company Rules, Policies and Practices

Rules and practices which were made explicit by the higher management, as well as those implicit in the behaviour and informal acceptance (eg. by not complaining about conditions and practices) of those in authority and of workpeople, contributed towards the supervisors' perception of the company rules, policies and practices. This perception was found to be a main factor prescribing the priority and importance to be accorded to various aspects of the work situation. There were strong pressures upon the supervisors by way of company procedures, and as a part of the client's or consultant's procedures for the control of work to ensure that the stipulated quality of work and schedule of progress were met. Supervisors were held accountable for the achievement of these clear and explicit targets, which received a higher priority than dealing with accident symptom occurrences for which there were no such pressures.
The following types of reasons were incorporated under this heading

a) The supervisor was following the instructions of his superior

b) According to company practice, the supervisor was not expected to allocate time, effort and/or resources to deal with the particular accident symptoms

c) The supervisor was expected to work with insufficient/ unsuitable resources

d) The safety officer, having seen similar conditions had not objected to or commented on them

e) The supervisor was not held accountable for dealing with the accident symptoms according to company practice

f) The supervisor was not expected to do any more than comply with legislation, towards safety on the site

g) It had not been made clear to the supervisor what procedures he was expected to adopt towards those accident symptoms whereas his production duties had been made clear.

14. Lack of Information

The cases where the supervisors lacked information vital to the safety of the particular situation were grouped under this heading. Hazards of materials and equipment, safe techniques and methods of operation, etc. which were not common knowledge amongst construction supervisors, as well as information concerning other activities in and around the area of supervision which had an influence upon the occurrence of accident symptoms were some examples of such information. The lack of information was found to be the result of one of the following

i., Those who should have supplied the information, eg. higher management, suppliers and manufacturers of plant, equipment and materials, consultants, safety officers, etc. had failed to do so

ii. The information, although sent off, had not reached the supervisor due to a communication breakdown, or had reached him in an inaccurate form

iii. The supervisor had not made the effort to study and understand or become familiar with the information provided.

Loss of content, misunderstandings, and transfer of ambiguous and inaccurate information were found to occur as a result of the absence of formal lines of communication and the common practice of transmission of most information by word of mouth.

The following types of reasons were incorporated in this category

a) Provisions, not accompanied by information regarding the special hazard control measures pertaining to them

b) Communication system faults prevented the information from getting through to the supervisor

c) The supervisor was not familiar with (had not read, noticed or understood) the information which did reach him

d) The supervisor lacked information concerning other operations which were either crucial to safety in the section or were affected by the activities in the section

e) The information provided was either inaccurate or ambiguous.

15. Legislation

The cases where legislation was a factor limiting supervisory perception of, and actions towards, accident symptoms were grouped under this heading. Supervisors in these cases were found to be of the view that safety in the sites was a matter of no more than complying with the regulations.

They also stated that they received better co operation from both the management and workpeople in dealing with accident symptoms which were breaches of the regulations than with others. However, some of the accident symptoms which the supervisors stated as not covered by the regulations were in fact breaches of the regulations. Also even in cases where they thought that there was a legal responsibility they resorted to other easier means of clearing that responsibility than actually dealing with the accident symptom. An example is given under (e) below.

The following types of reasons were incorporated in this category.

a) The supervisor believed that unless a breach of the regulations was involved, he did not need to be concerned with accident symptoms which were present.

b) Senior management, the safety officer and/or the workpeople were not concerned with accident symptoms which were not breaches of the regulations

c) The supervisor thought that legislation did not cover the particular situation although in fact it did

d) The supervisor allocated a higher priority to the cases which he thought were breaches of the legislation than others

e) When the workpeople did not comply with a legal requirement (eg. wearing of personal protection) the supervisor found other means of clearing his responsibility (eg. getting those persons to sign a statement that they had been instructed by the supervisor to comply) rather than dealing with the accident symptom

Data concerning the foregoing factors pertaining to each decision process is given in a table in the form of the number of accident symptom occurrences in which each factor was indicated to influence that decision. Tables 19 to 24 present this data.

Table 19 gives the data in the element 1.1 (factors influencing failure to recognise),

Table 20, those in the element 1.2.A (factors influencing failure to agree when pointed out),

Table 21, those in the element 2.1 (factors influencing the decision not to take action by himself),

Table 22, those in the element 2.2.B (factors influencing the decision that nobody ought to take action),

Table 23, those in the element 3.1 (factors influencing the lack of knowledge of a method of dealing with the accident symptom),

Table 24, those in the element 4, (other factors contributing to the presence of the accident symptom occurrence).

It is important to note that in the vast majority of the accident symptom occurrences, more than one factor was cited as influencing a particular decision. Therefore, in these tables, numbers opposite the factors add up to more than the total number of symptoms corresponding to that category. Data concerning the element 3.2.C (failure to agree on a suitable method of dealing with the accident symptom occurrence) were of a special nature. They were cases which needed specialized expertise which was neither possessed by the researcher, nor available in the site. Their implications to the study will be discussed later.

In the cases where insufficient data were available (Tables 19, 21, 23 and 24) tests of correlation between situational components were carried out using Kendall's Coefficient of Concordance W. The results of tests of significance are presented in those tables. k = no. of sets of rank n = no. of ranks in each set. Where the number of ranks in each set was greater than 7, (Tables 19 and 21) the sampling distribution was approximated by the X^2 distribution with n-1 degrees of freedom.

Data in Tables 20, 22 and 25 were insufficient in view of the small numbers in situational components for reasonably dependable test results. Therefore, tests were not carried out in these cases.

TABLE 19

Distribution of Accident Symptom Occurrences According to Reasons for Failure to Recognise Them

Influencing Factors	Work Setting	Provision	Personnel	System	Overall
1. Resource Limitations	-	-	-	-	-
2. Outside the Boundaries of Supervisory Duties	48	17	25	20	110
3. Incompatible Demands	7	5	2	5	19
4. Acceptance of Hazards as Inevitable	30	12	19	24	85
5. Influences of the Social Climate	-	-	-	-	-
6. Tradition in the Industry	41	13	27	23	104
7. Lack of Technical Competence	37	11	21	24	93
8. Dependence Upon the Individual Workmen	35	14	29	4	82
9. Lack of Authority	-	-	-	-	-
10. Contingency Situations	14	3	5	11	33
11. Safety Management System Factors	3	7	4	10	24
12. Task Overloading	-	-	-	-	-
13. Company Rules, Policies and Practices	9	17	16	28	70
14. Lack of Information	7	22	3	15	48
15. Legislation	8	5	1	3	17

Using Kendall's Coefficient of Concordance to test the significance of correlation between rank orders in the situational components $\chi^2 = 24.78$ $p < 0.01$ $df = 10$

TABLE 20

Distribution of Accident Symptom Occurrences According to Reasons for Disagreeing on Them

Influencing Factors	Work Setting	Provision	Personnel	System	Overall
1. Resource Limitations	-	-	-	-	-
2. Outside the Boundaries of Supervisory Duties	-	-	-	-	-
3. Incompatible Demands	6	2	1	0	9
4. Acceptance of Hazards as Inevitable	23	0	2	2	27
5. Influences of the Social Climate	-	-	-	-	-
6. Tradition in the Industry	17	1	3	2	23
7. Lack of Technical Competence	-	-	-	-	-
8. Dependence Upon the Individual Workmen	14	3	5	4	26
9. Lack of Authority	-	-	-	-	-
10. Contingency Situations	19	1	3	0	23
11. Safety Management System Factors	-	-	-	-	-
12. Task Overloading	-	-	-	-	-
13. Company Rules, Policies and Practices	-	-	-	-	-
14. Lack of Information	-	-	-	-	-
15. Legislation	8	2	2	1	13

No test for significance of correlation was possible because of the small numbers in some categories

TABLE 21

Distribution of Accident Symptom Occurrences According to Reasons for Thinking That the Supervisors Ought Not to Deal With Them

Influencing Factors	Work Setting	Provision	Personnel	System	Overall
1. Resource Limitations	87	55	61	37	240
2. Outside the Boundaries of Supervisory Duties	64	52	58	41	215
3. Incompatible Demands	41	27	25	33	126
4. Acceptance of Hazards as Inevitable	61	39	18	27	145
5. Influences of the Social Climate	59	18	33	23	133
6. Tradition in the Industry	80	14	17	21	132
7. Lack of Technical Competence	63	31	16	22	132
8. Dependence Upon the Individual Workmen	49	32	15	18	114
9. Lack of Authority	26	19	32	20	97
10. Contingency Situations	40	25	16	11	92
11. Safety Management System Factors	28	18	21	29	96
12. Task Overloading	32	19	14	10	75
13. Company Rules, Policies and Practices	16	11	12	30	69
14. Lack of Information	7	13	3	8	31
15. Legislation	7	2	3	6	18

Using Kendall's Coefficient of Concordance to test the correlation between rank orders in the situational components $X^2 = 40.325$ $p < .001$ df = 14

TABLE 22

Distribution of Accident Symptom Occurrences According to the Reasons for Thinking That Nobody Ought to Deal with Them

Influencing Factors	Work Setting	Provision	Personnel	System	Overall
1. Resource Limitations	-	-	-	-	-
2. Outside the Boundaries of Supervisory Duties	-	-	-	-	-
3. Incompatible Demands	5	2	1	3	11
4. Acceptance of Hazards as Inevitable	22	5	3	8	38
5. Influences of the Social Climate	-	-	-	-	-
6. Tradition in the Industry	6	1	2	2	11
7. Lack of Technical Competence	-	-	-	-	-
8. Dependence Upon the Indiviudal Workmen	3	2	0	3	8
9. Lack of Authority	-	-	-	-	-
10. Contingency Situations	8	2	1	4	15
11. Safety Management System Factors	-	-	-	-	-
12. Task Overloading	-	-	-	-	-
13. Company Rules, Policies and Practices	13	5	2	3	23
14. Lack of Information	-	-	-	-	-
15. Legislation	2	0	0	1	3

No test for significance of correlation was possible because of the small numbers in some categories

TABLE 23

Distribution of Accident Symptoms According to the Reasons for Lack of Knowledge of a Method					
Influencing Factors	Work Setting	Provision	Personnel	System	Overall
1. Resource Limitations	-	-	-	-	-
2. Outside the Boundaries of Supervisory Duties	65	22	27	19	133
3. Incompatible Demands	-	-	-	-	-
4. Acceptance of Hazards as Inevitable	-	-	-	-	-
5. Influences of the Social Climate	-	-	-	-	-
6. Tradition in the Industry	-	-	-	-	-
7. Lack of Technical Competence	38	17	23	31	109
8. Dependence Upon the Individual Work-men	-	-	-	-	-
9. Lack of Authority	-	-	-	-	-
10. Contingency Situations	-	-	-	-	-
11. Safety Management System Factors	24	8	46	16	94
12. Task Overloading	-	-	-	-	-
13. Company Rules, Policies and Practices	-	-	-	-	-
14. Lack of Information	18	14	20	13	65
15. Legislation	-	-	-	-	-

Using Kendall's Coefficient of Concordance to test the correlation between rank orders in the situational components, W = 0.575 weak association. k = 4 n = 7 for p = 0.05, W = 49.5

TABLE 24

Influencing Factors	Work Setting	Provision	Personnel	System	Overall
Distribution of Accident Symptom Occurrences According to 'Other' Reasons					
1. Resource Limitations	28	29	17	11	85
2. Outside the Boundaries of Supervisory Duties	-	-	-	-	-
3. Incompatible Demands	61	16	5	14	96
4. Acceptance of Hazards as Inevitable	-	-	-	-	-
5. Influences of the Social Climate	31	20	12	6	69
6. Tradition in the Industry	-	-	-	-	-
7. Lack of Technical Competence	-	-	-	-	-
8. Dependence Upon the Individual Workmen	-	-	-	-	-
9. Lack of Authority	-	-	-	-	-
10. Contingency Situations	54	12	8	13	87
11. Safety Management System Factors	25	17	10	8	60
12. Task Overloading	56	21	3	5	85
13. Company Rules, Policies and Practices	46	15	14	9	84
14. Lack of Information	-	-	-	-	-
15. Legislation	-	-	-	-	-

Using Kendall's Coefficient of Concordance to test the correlation between rank orders in the situational components, $W = 0.126$ very weak association. $k = 4$ $n = 7$ for $p = 0.05$, $W = 217$

TABLE 25

Distribution of Accident Symptom Occurrences Obtained by Combining the Tables 17 & 19					
Influencing Factors	Work Setting	Provision	Personnel	System	Overall
1. Resource Limitations	-	-	-	-	-
2. Outside the Boundaries of Supervisory Duties	-	-	-	-	-
3. Incompatible Demands	11	4	2	3	20
4. Acceptance of Hazards as Inevitable	45	5	5	10	65
5. Influences of the Social Climate	-	-	-	-	-
6. Tradition in the Industry	23	2	5	4	34
7. Lack of Technical Competence	-	-	-	-	-
8. Dependence Upon the Indiviudal Workmen	17	5	5	7	34
9. Lack of Authority	-	-	-	-	-
10. Contingency Situations	27	3	4	4	38
11. Safety Management System Factors	-	-	-	-	-
12. Task Overloading	-	-	-	-	-
13. Company Rules, Policies and Practices	13	5	2	3	23
14. Lack of Information	-	-	-	-	-
15. Legislation	10	2	2	2	16

No test for significance of correlation was possible because of the small numbers in some categories

CHAPTER 8

ANALYSIS AND DISCUSSION

- PART 2 OF THE STUDY -

8.1 Procedure Adopted

The coding of the detailed data collected from both the accident report investigations and the site interviews, presented in chapters 6 and 7, was a major step of the analysis of that data. Flanagan (1954) regarded this sorting and category generation process as the most vulnerable part of the critical incident method. In parts 1 and 2 of this study, the categories generated were as far as possible limited to those clearly emerging from the descriptions provided. That is, by the site personnel, in the case of the accident reports and by the supervisors, in the case of site interviews. A main drawback in the analysis, therefore, is the difficulty of assessing the relative importance of categories as a result of the possible presence of intercorrelations and interactions between them.

The wide variations between the type of construction firm, project, site and supervisors encountered in the construction industry was discussed in chapters 2 and 3. Although an attempt was made to include supervisory/site units of as great a variety as possible, it is very difficult to define the population of which the group of supervisors used in this study may be regarded as a representative sample for purposes of statistical analysis. However, the accident symptom occurrences, in view of the randomness of their choice, (limited to the ones found in the sites at random visits) were considered a random sample of a delimited population of those encountered by the group of supervisors used in this study. Kish (1959) advised caution in using tests of significance in exploratory investigations. He regarded an approach where only statements of the order "a relation exists between ..."

may be established, as almost essential in the first steps of research in a new field. In this study, statistical tests of significance were used in this limited sense, only to see if a relationship or difference existed which needed explaining or was of specific interest in some way.

Lykken (1968) maintains that statistical significance is the least important attribute of a good investigation. It does not indicate the degree of importance or the meaningfulness of the relations or differences which are important in a descriptive study. They have to be derived from other criteria, such as the size of the differences (using percentages) degree of correlation and the implications as regards the model and methods of investigation and so on.

Analysis and discussion of the results of part 2 of the study are presented in five separate sections. The first - Section 8.2 deals with the different stages of the supervisory decision process (eg. recognition, agreement when pointed out and so on); the second - Section 8.3 with the factors found to influence the safety role of the construction supervisor; the third - Section 8.4 with the safety role perceptions and the fourth - Section 8.5 with the comparison of supervisors belonging to different categories of each dimension on which supervisory variations were recorded. The fifth, a general discussion of the outcome of the previous four in relation to the objectives of this research is presented in Chapter 10.

8.2 Stages of the Decision Process

i. Failure of the supervisors to recognise the accident symptom occurrences on their own

Out of a total of 659 accident symptom occurrences, supervisors failed to recognise 287 (43.6%). The breakdown of

TABLE 26

Unrecognised Accident Symptom Occurrences				
	Work Setting	Provision	Personnel	System of Work
Total Number of A.S. occurrences	347	100	127	85
Number of unrecognised A.S. occurrences	113	36	78	60
Percentage unrecognised	32.6	36.0	61.4	70.6

$X^2 = 34.498 \quad p < 0.001 \quad df = 3$

these into situational components is given in table 26. It was found that a highly significant ($p < 0.001$) difference existed between the numbers of the unrecognised accident symptom occurrences belonging to different situational components. Supervisors failed to recognise a much higher percentage of accident symptom occurrences belonging to system and personnel components than to provision and work-setting.

The supervisor's ability to recognise the accident symptom occurrences in his section was found to be influenced by 11 of the total 15 factors discussed in chapter 7, (Table 19). It seems that the other factors were not relevant. Each factor was found to contribute to the failure to recognise a number of accident symptom occurrences belonging to each situational component. In view of the significant correlation ($p < 0.01$) between the rank orders of the factors (according to the numbers of accident symptom occurrences for which each factor was stated to be a contributory reason) in the situational components it is likely that the supervisors indicated the same reasons to explain their inability to recognise accident symptom occurrences in each of the situation components. It may therefore be concluded that in a particular group of supervisor site units, factors in those units influence the supervisory ability to recognise accident symptom occurrences belonging to different situational components in a similar manner. This is important in two ways. Firstly, in an investigation to highlight those factors, it may not be so important if there was a bias in the sample of the accident symptom occurrences used by the investigator as regards the proportion of those belonging to different situational components. The same influences are still likely to be identified. Secondly, dealing with the identified factors in an effort to improve supervisors' ability to recognise particular types of accident symptom occurrences are likely to improve their ability to recognise all types of accident symptom occurrences. These two results are felt to have important implications for the applicability of the techniques used in this research, in the investigation of specific cases.

Out of the unrecognised accident symptom occurrences, it is likely that supervisors were not expected to recognise some of them. For example, those which were the responsibility of specialists. As seen in table 19, supervisors themselves excluded 110 of those (out of 287) from their duties.

To what extent the supervisory perception of their duties was concurrent with the perceptions of the senior management was not verified in part two of the study because of the need for a general guarantee to the supervisors of the confidentiality of their information. In part 3, where the detailed investigations were limited to three sites in which no such guarantee was necessary, the perceptions of the supervisor's superiors and those of the Safety Officer were also examined. However, in the future investigation of a particular supervisor/site unit using the present tecnique the investigator will have to decide or find out taking all aspects of the situation into consideration, which of the unrecognised accident symptom occurrences need to be recognised by the supervisor, because the appropriate change programmes will depend on this decision. If supervisory recognition is necessary, then the change programmes will need to be directed at improving the supervisor. If supervisory recognition is not necessary, it implies the need for effective non-supervisory measures (eg. ensure the presence of other suitable persons who will effectively deal with this stage). The investigator's ability to arrive at the right decision in this respect is therefore crucial to the successful choice of change programmes.

The very high percentage of accidents symptom occurrences recognised by the supervisors (56.4%) by the fact that they still existed in the sites indicates that all those recognised are not necessarily dealt with. Therefore, although training for recognition is necessary, it is not sufficient for suitable action to occur.

Summing up

Supervisors failed to recognise a high percentage of accident symptom occurrences present in their sections.

They were better able to recognise work setting and provision types than personnel and system of work types.

11 factors were found to be relevant to influencing recognition (Table 19).

Reasons for failure to recognise were found to be similar for accident symptoms belonging to different situational components.

An investigator's decision regarding whether the supervisor should recognise the accident symptom occurrence, or whether appropriate non-supervisory measures should be made available to deal with this stage, is crucial for the effective choice of change programmes in general and supervisory training in particular.

ii. <u>Supervisors did not agree on the conditions pointed out by the researcher as accident symptoms</u>

Out of the 287 accident symptom occurrences that the supervisors failed to recognise, they disagreed in 54 cases (18.8%). The breakdown of these into the respective situational components is given in table 27. It was found that a highly significant difference ($p < 0.001$) existed between the numbers of disagreed accident symptom occurrences belonging to different situational components.

Supervisors disagreed on a much higher percentage of work-setting accident symptom occurrences than that of the other three types.
The reasons given by the supervisors for disagreeing came under 6 of the 15 factors (Table 20).
It seems that the other factors were considered not relevant.
The table indicates that there were only 3 cases where a factor was not a reason for any of the accident symptom occurrences of a particular type. These cases are most likely the result of the small numbers involved. Therefore, it may be concluded that each of the 6 factors can influence any type of accident symptom occurrence under different circumstances.
As a result of the small numbers coming under the Provision Personnel and System headings, it was not possible to subject Table 20 to a statistical test of association between the four situational components.
The high degree of acceptance of the supervisors (81.2%) of the unrecognised accident symptom occurrences pointed out by the researcher is an indication of the extent to which other persons (eg. safety officers, superiors, specialists etc.) can be effective in drawing the attention of the supervisor to them. It was not possible to examine the degree to

TABLE 27

Disagreed Accident Symptom Occurrences				
	Work Setting	Provision	Personnel	System of Work
Number of unrecognised A.S. occurrences	113	36	78	60
Number of disagreed A.S. occurrences	38	4	7	5
Percentage disagreed	33.6	11.11	8.97	8.33

$X^2 = 21.83 \quad p \quad 0.001 \quad df = 3$

which the credibility of those other persons in the eyes of the supervisor would have an influence on whether he agreed or not, although it is very likely that it would be an important determining factor.

It was apparent from Table 20 that disagreement on the accident symptom occurrences pointed out could be made on two different basic frames of reference. On the one hand, they may have disagreed that the condition could contribute to the occurrence of an accident (i.e. that the condition does not fall within the definition of an accident symptom). On the other hand, it may be a disagreement that even if it could, the condition was not to be considered a problem needing corrective action. Although the question was expected to elicit answers on the former basis, (the latter was examined subsequently by the question "did the supervisor think that anybody ought to deal with this accident cymptom occurrence" in element 2.2. of the flowchart) the type of reasons given indicate that they were given on the latter basis. In none of the accident symptom occurrences did a supervisor state that the condition could not contribute to the occurrence of an accident. It therefore seems that they accepted all the conditions as falling under the definition of an accident symptom. The disagreement was on whether they were conditions where corrective action should be taken, and hence these cases were considered more appropriate to be discussed together with those under the element 2.2.B (the supervisor decided that nobody ought to deal with the accident symptom) of the flowchart. It was therefore concluded that there was total agreement between the researcher and the supervisors on the conditions identified as accident symptom occurrences. This may be seen as an indication of the degree of effectiveness of the list of accident symptoms as a tool to arrive at a set of mutually agreed safety objectives for detailed discussion in the interviews.

The fact that the symptoms were not so much recognised as accepted has implications for the type of training needed to cope with problems at stage i. ie. it is not training in observation that is needed but training to make the supervisors realise that the symptoms can and should be removed.

Summing up

The degree of disagreement over whether the conditions pointed out by the researcher were accident symptom occurrences was very small.

There was a higher degree of disagreement over the work-setting type than the others.

In the case of those unrecognised by the supervisor on his own, other persons can be used to point them out to him with a high degree of effectiveness.

The disagreement indicated seem to be based on a frame of reference different from that intended by the question.

The list of accident symptoms were found to be a very effective tool for identifying a set of mutually agreed safety objectives to useas stimuli for focussed interviewing.

The reasons cited for diagreeing seemed more appropriate to be discussed under the category where supervisors considered that nobody should deal with them.

iii. Supervisors did not think that they ought to deal with the accident symptom occurrences

Having established mutual agreement between the investigator and a supervisor that a condition was an accident symptom either through recognition by the supervisor himself or acceptance after being pointed out by the investigator, the next stage of the decision process was whether the supervisor considered that he ought to take some action himself in order to deal with it.

Supervisors answered NO to this question in the case of 423 (64.2% out of the total 659). The breakdown on these into the respective situational components is given in table 28. It was found that a highly significant difference ($p < 0.001$) existed between the numbers belonging to different situational components.

A much lower percentage of worksetting accident symptom occurrences than the other three types were rejected by the supervisors as not to be dealt with by them. They seemed to feel that worksetting accident symptom occurrences were far more within their sphere of action than the others.

The supervisors' decision as to whether they ought to deal with an accident symptom occurrence was found to be influenced

TABLE 28

Accident Symptom Occurrences Rejected for Supervisory Action

	Work Setting	Provision	Personnel	System of Work
Total Number of A.S. occurrences	347	100	127	85
Number of A.S. occurrences rejected	180	78	101	64
Percentage rejected	51.9	78.00	79.53	75.29

$X^2 = 17.457$ $p < 0.001$ df = 3

by all the 15 factors (Table 21). The table indicates that each of those factors influenced the decision as regards a number of accident symptom occurrences belonging to each situational component.

A significant correlation ($p < 0.01$) was found between the rank orders of the factors (according to numbers of accident symptom occurrences for which each factor was stated to be a contributory reason) in the situational components. It is therefore likely that the supervisors indicated the same reasons for saying that they should not deal with the accident symptom occurrences in each of the situational components. Therefore, as discussed in the case of failure to recognise, here too the following two conclusions may be reached; that in an investigation, the same factors are likely to be identified even if there is a bias in the sample of the accident symptom occurrences used by an investigator; and that dealing with the relevant factors in any particular accident symptom will improve safety in all the four situational components.

It is clear from Table 18 that out of the accident symptom occurrences rejected as not to be dealt with by them, supervisors thought that only 215 were outside their duties (ie. not within the supervisors' responsibilities). It can therefore be considered that the other 208 were ones where even though not outside their duties, there were other constraints which made them decide that they ought not to do something about them. Here too it seems that answers could be given on the basis of two different frames of reference; whether the supervisor <u>should</u> take some action according to his responsibilities, and whether he <u>could</u> take action in view of other limitations and constraints of the situation. It appears from the table that both the 'should not' and 'could not' categories have been included here. This is understandable since they both resulted in a rejection of supervisory action. However, it is likely that some supervisors did not include the 'could not' category here when they considered that taking action was within their duty, but gave it under 'other reasons' in the element 4 of the flowchart. Thus, the questions, being formulated in general terms, elicited answers expressed in terms of different frames of reference. This variation is an essential characteristic of the study which was designed to accommodate information regarding individual perceptions and evaluations from all possible angles.

It is likely that the supervisors were not expected to take action with regard to some of the accident symptom occurrences, especially, where there were other effective measures envisaged. Therefore, in an individual investigation, the investigator will need to decide or find out which of those require supervisory action, so that the resulting change programmes could be designed so as to be appropriate to each specific set of circumstances, (see the follow up study in part 3). In the cases where supervisory action is necessary, the change programmes need to be directed at improving the supervisor, whereas in the other cases, they need to concentrate more on ensuring the appropriate non-supervisory measures to deal with them. It is unlikely that in a majority of the cases, both supervisory and non-supervisory measures would be found necessary.

Summing up

Supervisors considered that they ought not take action on a very high percentage of accident symptom occurrences.

A much lower percentage of worksetting accident symptom occurrences came under this category.

This category was influenced by all the 15 factors (Table 21).

Reasons for rejecting action by the supervisors were found to be similar for accident symptoms belonging to different situational components.

Supervisory answers were found to be based on different frames of reference.

Effective choice of change programmes was found to depend upon the investigator's awareness of all aspects of the organisation.

iv. <u>Supervisors did not think that anybody ought to deal with the accident symptom occurrences</u>

When a supervisor decided that he ought not to deal with an accident symptom occurrence, the next step in the evaluation process was to ask whether he thought that it should be dealt with by anybody at all. Supervisors answered NO to this question in the case of 67 (15.8%) of those that they rejected from supervisory action. The breakdown of these into the respective situational components is given in Table 29. A highly significant ($p < 0.001$) difference was found to exist between the numbers falling under the different situational components.

Supervisors answered NO to a comparatively smaller percentage of accident symptom occurrences belonging to Personnel and Provision components than Worksetting and System of Work components.

It was discussed under the heading "Supervisors did not agree on the conditions pointed out as accident symptoms" in ii. above, that those too were cases which the supervisors considered

TABLE 29

Accident Symptom Occurrences Rejected for Action by Anybody				
	Work Setting	Provision	Personnel	System of Work
Number of A.S. occurrences rejected for supervisory action	180	78	101	64
Number of A.S. " " " action by anybody.	43	7	5	12
Percentage of those rejected for action by anybody	23.9	9.0	4.9	18.7

$X^2 = 17.585 \quad p < 0.001 \quad df = 3$

as not to be dealt with at all and hence more appropriate to be categorised under the present heading. This is further supported by the fact that the factors cited as reasons in the two corresponding tables (Tables 20 and 22) were similar, there being only one additional factor cited in Table 22. The two tables are therefore combined and presented in Table 25 for further discussion.

A supervisor's decision as to whether anybody ought to deal with an accident symptom occurrence was found to be influenced by one or more of seven factors shown in Table 25. This table indicates that each of those factors influenced the decision as regards a number of accident symptom occurrences belonging to each situational component. In view of the small numbers coming under the categories, Provision, Personnel and System of Work components, it was not possible to test them for an association of the rank order of the factors.

The accident symptom occurrences coming under the present heading were not accepted at all by the supervisors as problems needing any sort of action for changing the situation. Therefore, they were unlikely to encourage and even likely to discourage other persons dealing with them. The number of accident symptom occurrences of this type being 121 (18.4%) of the total 659 used in this study, represents a substantial proportion. As such, in view of the gravity and size of the problem, this category demands special attention and particular effort for change.

Summing up

Supervisors considered that nobody should deal with a substantial percentage of accident symptom occurrences in their sections.

A comparatively higher percentage of worksetting and system components came under this category.
This category and the disagreed accident symptom occurrences (stage 2) were similar and therefore it was considered more suitable to discuss them together.
Seven factors were found relevant for influencing this decision (table 22).
Since supervisory influence is likely to be most disfavourable in dealing with the accident symptom occurrences coming under this category, they demanded special consideration in a change programme.

v. <u>Supervisors did not know a suitable method of dealing with the accident symptom occurrence</u>

The next step in the investigation was whether the supervisor knew a suitable method of dealing with the accident symptom occurrence. As is clear from the flowchart, those symptom occurrences on which he disagreed and decided that nobody should deal with were not included in this question.
Supervisors did not know a suitable method of dealing with 271 (50.9%) of the total 538 accident symptom occurrences which they thought should be dealt with. The breakdown of these into the respective situational components is given in Table 30. A significant difference ($p < 0.01$) was found to exist between the numbers falling under the different situational components.
The comparatively low percentage of work setting accident symptom occurrences in this category is an indication that the supervisors are better aware of the method of dealing with them. On the whole, they were far better aware of methods of

TABLE 30

Accident Symptom Occurrences for which the Knowledge of a Method of Dealing with was Lacking				
	Work Setting	Provision	Personnel	System of Work
Number of A.S. occurrences accepted to be dealt with	266	89	115	68
Number of A.S. occurrences for which knowledge was lacking	108	40	76	47
Percentage of those with lack of knowledge	40.6	44.9	66.1	69.1

$X^2 = 15.944$ $p < 0.01$ df = 3

dealing with work setting and provision types than personnel and system of work types.

As indicated in Table 23, the factors contributing to lack of knowledge of a suitable method were limited to only 4 of the 15 factors. A closer examination of the table reveals that those 4 were the only relevant ones. Each of those factors was quoted as a reason for a number of accident symptom occurrences belonging to each situational component. It was found that there was no significant correlation ($p > 0.05$) between the rank orders of the factors (according to the numbers of accident symptom occurrences for which each factor was stated to be a contributory reason) in the situational components. Therefore, reasons for lack of knowledge were likely to be different for accident symptom occurrences belonging to different situational components.

Out of the 271 accident symptom occurrences in this category, 133 were stated as outside the boundaries of supervisory duties. It implies that in those cases, supervisors did not need to know a suitable method of dealing with them. Although this part of the study, being limited to collecting information on the supervisory perceptions and evaluations was not designed to verify the appropriateness or accuracy of supervisory perceptions as regards their duties, in an investigation of a particular supervisor/site unit for purposes of introducing change programmes, the investigator will need to decide or find out whether those supervisory perceptions are the most appropriate in that particular situation(see the follow up study in part 3). If they are, it would indicate need for other change programmes to provide and/or improve the necessary non-supervisory measures. If they are not, it would be indicative of a primary need to change the supervisors' perceptions to include those cases within their duties, so as to make them more receptive, for the further change programmes necessary to improve thier knowledge in the case of the other 138 which were not excluded from their duties. Here too, the successful choice of effective change programmes therefore will depend upon the ability of the investigator to arrive at the right judgement of what should be included in the duties and what should not, in those particular circumstances. It may be appropriate to provide other effective measures, either instead of or in addition to providing supervisory knowledge.

<u>Summing up</u>

Supervisors did not know a method of dealing with a high percentage of accident symptom occurrences within their sections.
It was found that a higher percentage of work setting accident symptoms were within the knowledge of supervisors.
4. factors were found relevant to influencing the knowledge of supervisors in this respect (Table 23).
Reasons for the lack of this knowledge seemed different for accident symptoms belonging to different situational components.
In the choice of change programmes to improve site safety, it is necessary to establish whether or not the supervisor needs to possess the knowledge of a suitable method of dealing with the accident symptom occurrence.

vi. <u>A suitable method could not be decided by the researcher and the supervisor together</u>

Out of 271 accident symptom occurrences with which the supervisor did not know a suitable method of dealing, such a method could not be decided upon by the researcher and the supervisor in 38 cases (14.0%).

The breakdown of these into the respective situational components is given in Table 31. It was found that a significant difference ($p < 0.02$) existed between the numbers in the different situational components.

Percentages of System of Work and Work Setting types were comparatively higher than the Provision and Personnel types.

Each of the cases which came under this category were found to require specialised technical competence and information which were clearly outside the scope of the supervisor and also were lacked by the researcher for the purpose of deciding on a suitable method. These cases could be considered as an indication of the extent to which highly technical safety problems needing specialised expertise and information far beyond the scope of the site supervisors were present in the sites. They also show that an investigator, studying the needs for change programmes is likely to come across a number of such cases during the investigation. Although they represent a comparatively small percentage (5.8%) of the total accident symptom occurrences used in this study, in view of the likelihood of the problems being beyond the ability of control of the site personnel, it would be very important to identify them in order to ensure that effective change programmes (ie. making the specialised expertise/information available) are undertaken.

Summing up

It is likely that methods of dealing with a small percentage of the accident symptom occurrences in a site are beyond the investigator and the site personnel.

TABLE 31

Accident Symptom Occurrences for which a Method could Not be Decided by the Researcher and the Supervisor Together				
	Work Setting	Provision	Personnel	System of Work
Number of A.S. occurrences for which supervisor's knowledge was lacking	108	40	76	47
Number of A.S. occurences for which a method could not be decided by the supervisor and the researcher	20	3	4	11
Percentage of the ones not decided	18.52	7.50	5.26	23.40

$X^2 = 9.895$ $p < 0.02$ $df = 3$

In this study, there was a higher percentage of system of work and work setting types in this category.
Change programmes in such cases are likely to mainly consist of making the necessary expertise available.

vii. <u>Other reasons for the presence of an accident symptom occurrence</u>

The last question of the sequence of the interview was, for each accident symptom occurrence whether there were any other reasons (ie. reasons which had not been given in answer to the previous questions) for its presence in the site on that occasion.
Although this question was asked in all the 500 cases that ended up in the element 4 of the flowchart, new reasons were forthcoming only in 275 (55%).
They consisted of all the accident symptom occurrences which followed 1 → 2 → 3 → 4 (ie. those cases which the supervisors recognised, agreed that they ought to deal with, and knew a method of dealing with), the reasons for the presence of which were given only under this category, plus a small number of those which followed the other flowpaths. Since the supervisory decision processes and the factors influencing them were examined thoroughly in the previous questions, the cases mentioned under this category were most likely to be the constraints that the supervisors considered as external to themselves and which, although they did not influence the supervisors to reject the symptoms or the responsibility for dealing with them, inhibited their actions.
The breakdown of these into the respective situational components appear in Table 32. It was found that a highly significant difference ($p < 0.001$) existed between the numbers

TABLE 32

Accident Symptom Occurrences with 'other' Reasons				
	Work Setting	Provision	Personnel	System of Work
Total number of A.S. occurrences for which reasons were sought	246	86	111	57
Number of A.S. occurrences for which reasons were given	170	46	31	28
Percentages of ones for which reasons were given	69.11	53.49	27.93	49.12

$X^2 = 25.138 \quad p < 0.001 \quad df = 3$

in different situational components. Comparatively a very high percentage of worksetting and a very low percentage of personnel accident symptom occurrences were found in this category.

As shown in Table 24, the factors cited came under 7 of the total of 15. An examination of the table reveals that they were the only ones relevant. There was no significant correlation ($p > 0.80$) between the rank orders of the factors in the situational components.

The change programmes as regards these could be based on two basic approaches. One is to improve the supervisor so that he is able to overcome those external constraints by himself. The other is to deal with those constraints, so that they will not adversely influence site safety. It is most likely that the appropriate change programmes will have to be based on both of these approaches. What would be a proper balance between them will depend upon the particular circumstances. A proper judgement of this balance could be crucial for the effectiveness of the change programmes.

In view of the large number of factors external to the supervisor, which were highlighted by the supervisors as influencing their own perceptions and evaluations under the foregoing headings and as 'other' constraints under the present heading, it is evident that supervisors are a very effective source of information for investigations on needs of change programmes in general and supervisory training in particular to improve safety on sites.

However, the views of the other role incumbents of the site organisation on supervisory perceptions and evaluations would be crucial for the decisions concerning appropriate change programmes. The implications of the expectations of the supervisor's superiors and Safety Officer will be examined in part 3 of the study.

Summing up

A high percentage of accident symptom occurrences had reasons considered external to the supervisors which inhibited actions by supervisors as well as others.

A very high percentage of worksetting and a very low percentage of personnel types belonged to this category.

There were 7 relevant factors coming into influence as 'other' reasons for the presence of accident symptom occurrences.

These reasons were found to be different for accident symptoms belonging to different situational components.

Design of appropriate change programmes needs a good understanding of all aspects of the organisation.

Supervisors seem to be a very effective source of information on factors influencing the presence of accident symptom occurrences on sites.

8.3 Factors Influencing the Safety Role of the Construction Supervisor

The factors identified in this study as influencing the safety role of the construction supervisor were those highlighted by the supervisors themselves at the site interviews. The procedure adopted in the process of categorisation of the interview data into these factors and a short description of each factor were given in Chapter 7. The following is a discussion of the implications of these factors and their influence as regards the objectives of this study.

I. Resource Limitations

In 56.4% of the accident symptom occurrences which the supervisors did not think that they should deal with (element 2.1) and in 15.¼% of those for which reasons not involved with the supervisory decision process were sought (element 4), resource limitations was stated as a contributory factor.

Supervisors attributed the limitations of resources to the shortfalls of a number of different parties within the organization, such as senior management and maintenance sections, as well as a large number of other influences from within and without the compay. The space available within the site premises was almost always dependent upon the nature of the location. Geographical characteristics and the surrounding activities played an important part in this respect. Limitations of personnel were attributed to factors such as scarcity of suitable workpeople for certain jobs, faults of sub-contractors upon whom the main contractor depended, high rate of labour turnover, absenteeism etc.

As a result of fluctuations in supply and demand, in the case of some vital materials, construction contractors were at times said to be faced with a sellers market and in such cases, the supplier was regarded as having the whiphand. Whereas the contractor was bound by the damages clauses in the agreement to complete the work in a specified time to a specified quality, the suppliers could not be held to such a commitment.

In view of the need to maintain a satisfactory progress of work, due to contractual bonds and other pressures from economic and other organizational requirements, site personnel had to continue to carry out their tasks in spite of resource limitations. Supervisors seemed to experience considerable difficulty in meeting the technical and managerial demands of safety functions in such cases. They also stated that the need to continue work progress with limited resources was often not compatible with maintaining safety. In order to cope with such difficulties and incompatibilities, they seemd to impose limitations upon the expectations of their safety functions.

It appears from the above that the resource limitations could be due to a large variety of causes from within as well as without the company. They seemed to make the supervisor decide that he should not or could not take action to deal with the accident symptom occurrences and/or other personnel failing to take suitable and effective action.

Training Implications

There appear to be two different basic objectives towards which a change programme might be directed. The first, and the more important, is to minimise the resource limitations. This may be achieved by adopting a variety of non-training measures, such as securing more space for construction activities, improving supplies, ensuring more efficient maintenance and so on. Training supervisors and other management personnel, to improve planning, to ensure better supply or resources as well as to use the available resources in a more efficient manner, also is likely to be effective. However, it is unlikely that resource limitations could be avoided altogether on a construction site. The second objective therefore, is to ensure that suitable action is taken to deal with accident symptom occurrences when resource limitations do occur. Methods of achieving this are likely to concentrate more on site personnel. For example, selection, training, instruction etc., of the workforce, supervisor and the senior management. Training of the supervisor therefore, seems only one of many methods of dealing with accident symptom occurrences arising out of resource limitations. Indeed, in most circumstances, it might only be a small fraction of an effective change programme.

II Outside the Boundaries of Supervisory Duties

In 38.3% of the unrecognised accident symptom occurrences (element 1.1) 50.8% of those with which the supervisors did not think that they should deal (element 2.1), and 49.0% of those with which supervisors did not know how to deal (element 3.1), the supervisors considered the activities to be outside their duties. It appears that all these three functions, recognition, action and knowledge of what should be done, are affected to a considerable degree by this factor.

A vast majority of the works concerned were of a type carried out by specialist workmen, wherein the methods, techniques and working conditions including safety aspects were considered the concern of the particular workmen. The supervisors also, in some cases, thought that it was not their responsibility to carry out safety checks or inspections. Those responsibilities were attributed to the safety officer or the specialist workmen themselves.

In this study which was limited to supervisors' perceptions and evaluations, no attempt was made to ascertain whether the distribution of responsibilities as stated by the supervisor in a particular case was in accord with the views of higher management. However, it would be crucial to verify this in the case of an investigation to establish change programmes suitable for a particular supervisor site unit, because the nature of such change programmes would be dependent on it. For example, if the senior management agreed with the supervisor, then the change programmes would need to emphasise non-supervisory means of overcoming the problems. If the supervisor's perception of the responsibility structure was regarded as incorrect, then changes would need to incorporate means of ensuring that the supervisor had a clearer understanding of his own responsibilities as well as those of others (see the follow up study in part 3).

However, it is important to be conscious of the fact that the most appropriate change in a particular situation could be to change the perception of the senior management, in which case training should be directed at them. It is very likely that different members of the construction team would have acquired different frames of reference. Maier et al (1961), found that even if a man and his superior were in agreement concerning the content of the former's job, they frequently disagreed regarding the priority which should be accorded to the various duties.

In a majority of the cases in this research, supervisors stated that fixed or clearly expressed responsibilities for ensuring safe methods of work were absent. Burns (1963) pointed out that this lack of clarity concerning the responsibility was a characteristic of organismic organisations which have to cope with rapid change. This was discussed in detail in Chapter 2. Jaques (1963) pointed out that the word 'responsibility' is used in far too general a sense. He criticised the frequent careless and loose application of this term. He stated that "By responsibilities I wish to refer, therefore, simply to the particular activities to be carried out in the job with the results to be achieved stated in concrete terms of the specific things". Most construction supervisors in the sites visited had a set of results stated in clear terms pertaining to production requirements but not to safety. Within these objectives different supervisors were found to adopt different ways of behaving. Their job in that sense was largely discretionary rather than prescribed: a distinction made by Jaques, (1956). Within this discretionary element, supervisors were inclined to pass over many safety functions, which had not been specifically stated as their own, to other parties such as safety officers, senior managers, sub-contractors, suppliers, maintenance departments, indiviual workmen etc.

Lack of clearly understood safety responsibilities was also found the be the cause of much uncertainly and misunderstanding eg. on several sites studied, the supervisor expected certain facilities which were crucial for safety in a sub-contractor's job to be brought in by the sub-contract gang, whereas the sub-contractor expected them to be provided by the main contractor (supervisor's organization). In the end, the workmen had to do the job with insufficient and unsuitable facilities in a very unsafe manner. In such situations, apart from the probability of experiencing uncertainty regarding an individual's own duties and responsibility, the situation would be aggravated by his perceptions of the duties and responsibilities of the others in the organization. Renken and Lawrence (1952) found that differences in assumptions (orientation) between groups were related to difficulties in achieving collaboration. Each individual evolved his own frame of reference different from those of his colleagues. Kahn et al (1964) found that 35% of the respondents in their investigation were disturbed by the lack of clarity concerning the scope of responsibility of their jobs.

Supervisors were free, within the discretionary element of the job to carry out any activities or functions which were acceptable to the workmen and superiors towards achieving the stated organisational goals. Rackham et al (1971) called this goal obsession. However, the goals which had been made clear were often those concerning production, not safety and it was to the former that supervisors attached a greater priority.

It appeared that the safety responsibilities of different parties on a site were often established by interpersonnel agreement between the parties involved on the site at any particular time. However, at times, the decisions regarding the scope of safety duties were also made somewhat arbitrarily by the individual himself. On occasions it seems to have resulted in situations in which everyone left some aspects of safety to everyone else, so that ultimately no one attended to such aspects. In such a work atmosphere, supervisors seemed to limit some of their safety functions by categorising them as outside their duties.

A clear understanding of the supervisors' and others' safety responsibilities together with the results to be achieved, is essential in order to improve safety on sites. It appears that the higher management or an investigator needs to be clear about these before deciding upon the appropriate programmes.

Training Implications

In view of the critical nature of the supervisor's job (eg. co ordination, direction etc. functions) and the significance of the interaction of different activities for safety, a detailed understanding of his own safety responsibilites, as well as those of the others, whose activities may influence his work area, represents a clear training need of the supervisor. This understanding is likely to be particularly vital in obtaining interpersonal agreement concerning safety functions in on-the-spot negotiations as regards site arrangements. However, it seems crucial that persons other than the supervisor should also be part of such a change programme.

In different firms and different projects of the same firm, supervisory safety duties were found to be subject to wide variation. They also varied with the progress of work. Therefore getting the supervisors and others to be clear about their safety duties seems a continuous need on construction sites.

III Incompatible Demands

In 6.6..% of the unrecognised accident symptom occurrences (element 1.1), 16.7% of the ones disagreed as accident symptom occurrences (element 1.2.A), 29.8% of the ones which the supervisors did not think that they should deal with (element 2.1), 16.4% of the ones that they thought nobody should deal with (element 2.2.B) and 15.2% of those for which reasons not involved with the supervisory decision process were sought (element 4), incompatibility of deamnds was cited as a contributory factor.

It appears that this factor influenced every stage of the decision process of supervisors in a proportion of accident symptom occurrences on the site.

The work demands upon supervisors were found to come from various sources and consist of many different aspects. Quality of work, high speed of progress, the need to use minimum, limited or sometimes less than suitable resources, maintenance of safe conditions of work, co ordination between different work groups were some of them. It is not surprising therefore that at times, one set of objectives were able to be realised only at the expense of another. Demands concerning economic and output aspects of the site as well as the values and expectations of different parties involved with the work activities were particularly felt to be incompatible with maintaining a safe work site. Conflicts between different demands often made it necessary for the supervisors to lower their expected level of achievement in areas which they considered less important than others. Production goals which were clearly stated and for which supervisors were held accountable often received a higher priority than keeping the site free of accident symptoms. As a means of coping with the 'role strain' caused by demands requiring separate and irreconcilable courses of action, they decided to ignore accident symptom occurrences.

The goals, values and interests of the supervisors often tended to differ to a greater or lesser extent from those with whom they worked. Lennerlöf (1968) pointed out that it is very common to find conflicts between expectations held by different parties in the situation. In such cases the attainment of the goals of one party can only be achieved at the expense of anothers'. Supervisors in many such cases, appeared to surrender their expectations and revise their goal priorities in order to maintain good relations with the work groups and other members of the construction team.

Training Implications

A change programme to improve site safety should therefore include measures to ensure that the work demands upon supervisors are as far as possible compatible with maintaining an accident symptom free worksite. However, it is unlikely that such incompatibilities could be avoided altogether on construction sites. Whenever the necessary safety demands are irreconcilable with other work demands, additional measures including suitable training are therefore likely to be necessary to ensure that the supervisors and other site personnel allocate the appropriate priorities to these different demands without undermining safety.

IV Acceptance of Hazards as Inevitable

In 29.6% of the unrecognized accident symptom occurrences, (element 1.1), 50.0% of the ones disagreed as accident symptom occurrences (element 1.2.A), 34.3% of the ones that the supervisors did not think that they should deal with (element 2.1) and 56.8% of the ones that they thought nobody should deal with (element 2.2B) acceptance of the accident symptom conditions as inevitable was cited as a contributory factor. Supervisors believed that the construction industry was hazardous by nature, and that the occurrence of certain accident symptom conditions was an unavoidable characteristic of construction projects. They thought that if safety requirements were complied with to the letter, work progress would be substantially restricted.

This factor seems to influence practically every stage of a supervisor's decision process. In this study, no attempt was made to investigate the criteria which supervisors used to decide which accident symptom occurrences they would consider unavoidable. However, it is likely that these beliefs are linked to traditional practice in industry. Since supervisors invariably have a background of long experience in construction, these beliefs are usually deep rooted. It is also very likely that these attitudes are shared or reinforced by other work associates.

<u>Training Implications</u>

In an industry, which by its very nature, is accompanied by a large number of hazards, it is not surprising that the workforce, after a period of site experience, accept some of these as inevitable. However, with the increasing concern of society for safer working conditions there is a need for continuing effort to decrease the acceptance of hazards among the supervisors as well as other site personnel. The change programmes, most appropriate in this respect appear to be largely of a training or supervisory nature. A gradual change of attitude of all construction personnel by repeated training programmes seem essential to ensure the removal of many hazardous situations that have come to be accepted on present day construction sites.

<u>V Influences of Social Climate</u>

In 31.4% of the accident symptom occurrences which the supervisors did not think that they should deal with (element 2.1), and 11.8% of those for which reasons not involved with the supervisory decision process were sought (element 4), influences of the social climate was cited as a contributory factor.

Homans (1950) described social systems in terms of activities, interactions, sentiments and norms. Individual actions are greatly influenced by their acceptability to the social group to which the individual belongs. Whenever there is a need to behave in a way of which the group disapproves, the individual is most likely to respond to the pressure of the group. Dubin (1962) pointed out that the social control systems of small groups are much more effective than the procedures of control devised by the large organization of which the group forms a part. The position of the construction supervisor isolated from his employing organization and in close contact with his subordinates is particularly vulnerable to pressures of this kind from the workforce.

In the construction industry, the main contractor is usually dependent on the other parties involved for the smooth execution of the production process. Negotiation and agreement are the most common ways of maintaining social organisation and co ordination between activities. As the main co-ordinator of the works in his section, the supervisor has to ensure interpersonnel agreement and harmony in the workplace. Maintaining good relations with and between different work groups and individual workmen with varying interests was found to be very important for successful discharge of the supervisors' duties.

The value criteria of most work groups were stated by the supervisors to be not conducive to safety. The majority of operatives and sub-contractors were paid, on the basis of piece- work. Hence they were strongly motivated towards completing their jobs speedily. Work people in this way had a powerful incentive to "cut corners" and ignore accident symptom occurrences. Apart from the reluctance to interfere with the way the operatives worked, supervisors also had a vested interest shared by the senior management in early completion of the jobs. Under such circumstances supervisors were found to decide that they should not deal with some accident symptom occurrences.

Supervisors also stated that, when they were posted to a site where work had already been in progress, they considered that receiving acceptance by the site personnel was more important than dealing with accident symptom occurrences. As discussed in Chapter 2, construction personnel elaborate their relationships beyond the formal requirements to form an 'informal' organization in order to cope with the immediate demans. The role of the supervisor in this informal organisation, as expected by and acceptable to his work associates made it necessary for him to neglect dealing with some accident symptom occurrences which his formal role stated that he should deal with.

Training Implications

Change programmes in such cases need to be desinged to improve the social climate of the worksite in general so that safety activities are accommodated without difficulty. Since the working gangs as well as factors determining the social climate in a supervisory section keep changing frequently, supervisors are likely to be exposed to changing conditions of social climate. Therefore, in addition to the need for such change programmes to be undertaken on a continuous basis, it seems essential that the supervisors are trained to be able to take suitable action on accident symptom occurrences even when the social climate is not conducive. Support from the higher management also is likely to be crucial for the success of such supervisory actions.

VI Tradition in the Industry

In 36.2% of the unrecognised accident symptom occurrences (element 1.1), 42.6% of the ones disagreed as accident symptom occurrences (element 1.2.A), 31.2% of the ones that the supervisors did not think that they should deal with (element 2.1) and 16.4% of the ones that they thought nobody should deal with (element 2.2B), tradition in the industry was cited as a contributory factor.

The construction industry is based on well established traditions which can be traced back through a very long history. The processes of introduction, training, socialization and experience of supervisors into the industry and the supervisory job were discussed in detail in Chapter 2. Having developed their own work practices in this manner according to these traditional ways of work and having got accustomed to them throughout their working life, supervisors tend to comply with them without doubt or question. Some of these traditional work practices incorporate accident syptom occurrences, which are therefore allowed to persist. The supervisors also sometimes found it difficult to come to grips with technical changes which had altered the basis of the practices with which they were familiar. In such cases, the probability of the occurrence of accident symptoms increased.

All categories of persons working in this industry learn the formal skills and techniques, as well as informal work practices and ways of conduct, on the job (Chapter 2). Being an integral part of their 'experience' in construction works, many types of accident symptom occurrences are likely to have become accepted as traditional conditions by the supervisor's work associates too.

When the traditional working practices of the other site personnel were contrary to maintaining an accident symptom free work site, they provided a source of conflict so that even though the supervisors were aware of the accident symptoms, they accepted them and/or decided not to take action with regard to them in order to maintain good relations.

Training Implications

Traditional practices are usually established to meet essential demands in the industry and are often deep rooted and widespread. It would not be realistic to expect the supervisors or any other single group to change most of them. Also, an attempt to introduce change on the basis of the findings of a purely technical study is likely to run into all sorts of conflict from different groups. To be effective any change programme should therefore need the involvement, co-operation and commitment of all the parties concerned within the industry. Training of supervisors, although very important and essential, in this respect, would be only a small fraction of a much wider programme.

VII Lack of Technical Competence

In 32.4% of the unrecognised accident symptom occurrences (element 1.1), 31.2% of the ones that the supervisors did not think that they should deal with (element 2.1) and 40.2% of the ones with which they did not know how to deal (element 4) lack of technical competence was found to be a contributory factor.

A distinction needs to be made here between the lack of competence in areas which were within the supervisory duties and those without. As discussed under the section "Outside the Boundaries of Supervisory duties" above, the two cases suggest different change programmes, to achieve an improvement. Gaps in competence were not surprisingly found in the cases where supervisors stated that the activities were outside the boundaries of their duties. This may indeed by why they were so considered. However, they were also not technically competent to cope with a large number of accident symptom occurrences which were not stated as outside their responsibility.

It was also found that in a number of cases, the company had assigned to the supervisor certain specific safety functions although he did not possess sufficient competence to carry them out. Inspection and authorization of scaffolds and excavations were common examples.

In a number of cases encountered, supervisors possessed the knowledge of the standards to be achieved, but were not able to achieve them in practice. For example, they knew the regulations, but did not know how to get the workmen to comply with them, within the particular organizational climate. This indicates the importance of the ability to achieve practical results within the variables and constraints of the actual site situations, in addition to gaining formal knowledge of desired standards and performance levels.

Training Implications

In order that the change programmes are most appropriately directed, it seems necessary to establish in which areas the supervisor needs to be competent, and also those areas in which competence is not essential. (eg. in certain specialist operations, where safety is a part of the specialist functions of the team engaged, the supervisor's safety competence may not be essential). When a lack of competence is identified in the assigned functions of a supervisor, it would directly indicate a need for the training of the supervisor in the relevant technical and mangerial functions.

VIII Dependence upon the Individual Workman

This factor appeared in the elements 1.1, 1.2.A, 2.1 and 2.2.B of the flowchart.

In 28.6% of the unrecognized accident symptom occurrences (element 1.1), 48.2% of the ones disagreed as accident symptom occurrences (element 1.2.A), 27.0% of the ones that the supervisors did not think that they should deal with (element 2.1), and 11.9% of the ones that they thought nobody should deal with (element 2.2.B), dependence upon the individual workman to cope with the accident symptom occurrence without sustaining an accident was stated to be a contributory factor.

Supervisors stated that the job of a construction worker was very individualistic. Different workmen would complete the same task in different ways and there was no one best way to do the job. Most instructions to workmen were given in the form of results that needed to be achieved, rather than as a detailed description of how exactly the work should be done. In the process of carrying out a job, the operatives themselves had to make many on-the-spot decisions as to what and how things should be done. Supervisors considered that the nature of a construction workman's job was such that they had to be depended upon to cope with many accident symptom occurrences on their own.

In view of the realities of the construction situation (Chapter 2) where most workmen arrange and manipulate the situational components to suit their own personal convenience, engage in more daring feats than the average individual, lack understanding and awareness about the rest of the works in progress in and around their work area, and often have poweful incentives or pressures to cut corners to speed up the work, it is not reasonable to depend upon them to cope with the accident symptom occurrences on most occasions. In addition, supervisors stated that in general, this ability to work safely was not a criterion of selection of operatives, for a majority of the jobs. Very few of them had any sort of training in safe work practices. Therefore, apart from the cases where the persons were specially selected and trained to cope with the hazards in their work, and were able to do so under the particular site circumstances, with no other persons exposed to those hazards, it may be argued that in all other cases, the persons are likely not to be able to cope with hazards without giving rise to accidents.

However, supervisors seemed to ignore a fair proportion of the accident symptom occurrences in practically every stage of the decision process on the grounds that the work people were able to cope with them. This attitude is likely to be supported by the past experience of the supervisors in the industry and reinforced by the behaviour and expectations of the other parties in the construction works.

Training Implications

In view of the above, it seems that training the supervisors so as to enable them to come to the right judgement as to when the operatives can be depended on to cope with the hazards, would be a supervisory training need. However, in order to ensure that the training is effective, it is likely that there would be a need for other measures, such as similar training of other construction personnel, proper selection and training of those operatives whose skills are to be depended upon etc..

IX Lack of Authority

In 22.9% of the accident symptom occurrences which the supervisors did not think that they should deal with, (element 2.1), lack of authority was cited as a contributory factor.

As discussed in Chapter 3, there seems to be a lack of a standard authority structure on most construction site organizations. In view of the presence of a number of independent groups operating on a contractual basis, the negotiated social order and the degree of variation from one site to another, the behaviour of individual supervisors and thier work associates is directed by their own personnel conceptions of the authority structure. For example, Thurley and Pinschof (1965) noted that building site agents considered that they had far more power than they were ascribed by the company.

Absence of a defined structure in the organisation heightens the probability of individuals experiencing a lack of clarity regarding their authority. The situation is made even worse when considering the perceptions of the authority of others in the firm. When a supervisor lacks sufficient control over a situation, it is unlikely that he will initiate an action, lest someone might see it as an overstepping of his authority. Although, status as a supervisor may seem to imply some sort of managerial authority, formal authority and status recognized by management may be different from the informal status and authority recognized by workers, sub-contractors and other work associates. The resultant uncertainty of the supervisors of their own authority and that of others, is likely to inhibit some supervisory actions towards safety.

There were also circumstnaces, where supervisors had to surrender some of their perceived authority and decide not to act, in view of the conflicts encountered with workpeople or superiors.

Training Implications

A clear understanding by supervisors of the different contractual and other relationships and their effect on their authority seems essential to ensure correct supervisory actions regarding certain accident symptom occurrences. This indicates a clear training need of supervisors. It is likely that in many cases there is also a need for a similar understanding by other work associates of the supervisor. Due to the wide variation of the formal and informal authority structures in different circumstances and in the case of different participants in a project at different stages, it seems necessary for the supervisors, as well as others, to be kept up to date with the changes on a continuous basis.

X Contingency Situations

In 11.5% of the unrecognized accident symptom occurrences (element 1.1), 42.6% of the ones disagreed as accident symptom occurrences (element 1.2.A), 21.8% of the ones that the supervisors did not think that they ought to deal with (element 2.2.B) and 13.4% of those for which reasons not involved with the supervisory decision process were sought (element 4), the contingency nature of the situation was stated as a contributory factor.

The features of the industry discussed before (in Chapter 2) which occasion various forms of uncertainty, result in the work being highly prone to interruptions from contingencies. The disruptions and strains caused by such situations requiring emergency measures, seem to influence every stage of the decision process of a supervisor concerning accident symptom occurrences.

Contingencies involve on-the-spot decisions where standard solutions are not available and it is difficult to use a systematic problem solving technique. Supervisors were found to jump to hasty decisions and accept precedents from previous experience to "patch up" and overcome such temporary problems. It was often stated that all construction personnel ignored many accident symptom occurrences in such situations. Absence of sufficient time to think through the problems and obstacles to the successful use of standard methods known to the supervisor meant that potential accident symptoms were not highlighted in association with the particular jobs.

Many text books on supervision emphasize the need to train supervisors to use a systematic problem solving technique eg. Yuill (1968). However, it was found that construction supervisors often did not get the opportunity to do a proper analysis and use such techniques successfully with regard to the safety aspects of the contingency situations they commonly encountered. This is not to say that systematic problem solving techniques are not useful. Obviously they are in the vast majority of the cases. In fact, many contingency situations can arise becuase of the lack of their use. It seems that there is also a great need to be able to identify and deal with accident symptom occurrences as and when they arise during the execution of on-the-spot decisions to deal with hasty, unprepared for conditions and activities. Many accident symptom occurrences arising out of contingencies were found to be temporary in nature and lasted for only a comparatively short duration. If the effort, time and resources needed to deal with them were substantial, supervisors often decided to ignore them. It was also pointed out that this attitude was reinforced by a similar approach from other work associates.

Contingencies seemed to give rise to conditions where the supervisors found it difficult to meet the technical and managerial demands of the safety aspects of the situation, as well as creating incompatibility between the safety and production expectations of their role.

Training Implications

Adopting appropriate measures, including training, to reduce the number and the gravity of contingency situations represents one change route. Training of supervisors to allocate due consideration and importance to identifying and dealing with accident symptom occurrences when handling contingencies also seems essential. However, similar training of other work associates is likely to be crucial, so as to gain their co-operation, if such supervisory training is to be effective.

XI Safety Management Systems Factors

In 8.4% of the unrecognized accident symptom occurrences, (element 1.1), 22.7% of the ones that the supervisors did not think that they ought to deal with (element 2.1), 34.7% of the ones for which the supervisors did not know how to deal (element 3.1) and 28.6% of the ones for which reasons not involved with the supervisory decision process were sought (element 4), inadequacies of the safety management system factors were stated as a contributory factor.

The framework within which supervisors carry out their functions is set by the higher management, who sanction goals and norms for the functioning of the system as a whole and its various sub-systems and components. The mechanisms for social control, feedback etc. to ensure the adherence to these norms and the attainment of the goals are also stipulated by the higher management. Therefore, the system of safety management within the site, as implemented by the senior managers exercised a considerable influence upon the decision process of the supervisors concerning accident symptom occurrences on the sites visited.

When the accident symptom occurrences were the result of absence of, or shortfalls in, the safety management system factors, often they did not appear in the supervisory consideration at all. For example, if proper systems to ensure periodic inspection of cranes, hoists etc. had not been implemented in the company, supervisors were found not to be concerned with them.

Also, if dealing with accident symptom occurrences involved introduction of new systems or modifications of the existing ones, supervisors tended to consider those as beyond the scope of their level of functions and hence decide not to take action.

The overall systems of the organization of the company should consist of adequate safety provisions to provide guidance for the safety functions of supervisors. In the cases where such provisions have not been made it is not realistic to expect the supervisors to put them right.

Training Implications

Provision of effective and adequate overall safety management systems, therefore, seems an essential pre-requisite to supervisory training. Once such a system has been established, training of supervisors and other categories of personnel may be found necessary to ensure their proper understanding and effective implementation.

XII Task Overloading

In 31.4% of the accident symptom occurrences that the supervisors did not think that they ought to deal with (element 2.1) and 13.0% of the ones for which reasons not involved with the supervisory decision process were sought (element 4), task overloading of the supervisor was stated as a contributory factor.

Due to the project nature of construction operations, there is a considerable variation with time in the quantity and the make up of the workload of every individual. Supervisors stated that often, they had more things to do at any one time than they could physically manage. Contingency situations, tight deadlines, sudden changes in the work climate, were some circumstances which produced task overloading. In general, supervisors found that the production demands for which they were held accountable were highly demanding and that most safety functions resulted in an additional increase of those demands. In a survey carried out by Kahn et al (1964) in American industry, task overloading was found to be a problem among about 45% of the respondents.

As a means of coping with task overloading, supervisors limited their work load by neglecting some tasks and adopting a reactive approach to some functions - a form of crisis management. Under such circumstances, they found it impossible to fulfill their complete safety role. Supervisors were found to ignore accident symptom occurrences for the following reasons:

(a) Dealing with the accident symptom occurrence was considered less important than attending to a number of other jobs which filled up their time

(b) The supervisor did not have known or unabmiguous solutions to the problem of dealing with the accident symptom occurrence

(c) There was no immediate outside pressure to take action (ie. action had to be taken on the supervisor's own initiative).

Training Implications

Measures to ensure that the workload on the supervisor does not exceed the limits of his ability to cope seem an important objective for a change programme, in this respect. However, in order that the supervisor takes suitable action if overload does occur, training may be directed at ensuring that the supervisor allocates the appropriate priority to dealing with accident symptom occurrences in such circumstances. Getting the supervisors into the practice of seeking out accident symptom occurrences and dealing with them on their own initiative when their workload is not great also may help to even out the workload.

XIII Company Rules, Policies and Practices

In 24.4% of the unrecognized accident symptom occurrences (element 1.1), 16.3% of the ones which the supervisors did not think that they ought to deal with (element 2.1), 34.3% of the ones that they did not think anybody should deal with and 12.8% of those for which reasons not involved with the supervisory decision process, company rules, policies and practices were cited as a contributory factor.

The way the supervisors perceived the rules, policies and practices of the company was found to be a main factor prescribing the functions of site personnel and the priority and importance to be accorded to various aspects of the work situation. Some accident symptom occurrences in the sites were seen by the supervisors as in accordance with explicit company procedures (eg. the procedures laid down for stacking storing, transport, not safe). Others were implicit, for example, safety officer in his inspections never complained about them.

As a result of established procedures in the firm which accepted accident symptom occurrences, supervisors had difficulty in meeting the safety demands of certain situations. Also, there were cases, where the safety functions were not compatible with production functions which were given a higher priority by the company procedures and for which the supervisors were held accountable. Under these circumstances supervisors reduced their expectations of the safety role.

Training Implications

It therefore seems that ensuring that the rules and practices established in the site do not promote the presence of accident symptom occurrences is a vital pre-requisite to other change programmes. This may have to include measures to ensure that the procedures emphasise sufficiently the importance of dealing with the accident symptom occurrences in comparison with the functions relating to production. Cultivating a proper understanding of the company procedure amongst the supervisors as well as other work personnel by way of training may be found a necessary safety training need. However it is not realistic to expect training to equip supervisors to go against what they perceive to be company rules, procedures or practice.

XIV Lack of Information

In 16.7% of the accident symptom occurrences unrecognized (element 1.1), 7.3% of the ones which the supervisors did not think that they ought to deal with (element 2.1), and 24.0% of the ones with which they did not know how to deal, lack of information was cited as a contributory factor. It was stated that in the construction industry, supervisors and other personnel often came across materials, equipment and techniques which they had not come across before. This was a result of technological innovations as well as the variations in the different projects and firms. Often no one had communicated effectively, the information regarding the ways of identifying and dealing with the accident symptom occurrences associated with these innovations.

Construction operations are characterized by a high level of interdependence between individuals drawn from many different organizations. Supervisors were also found to lack information regarding the activities being carried out by some of these parties in their area of supervision. Such information was crucial if the supervisors were to deal with certain accident symptom occurrences. The rapid changes taking place in supervisory sections most of the time affected by the different parties, made information about these activities even more crucial. Moonman (1961) pointed out that industries which have to cope with rapid changes require a greater level of communication among managers than industries with more

stable environments in order for them to stay tuned to the changing environment. However, in most sites, supervisors felt that the information flow in connection with safety between sections, different groups, and up and down the line management chain was not adequately efficient.
Supervisor's lack of information was found to be due to one of the following reasons.

I. The information had not been supplied by those who were responsible for doing so.

II. Fault of communications, causing distortions in the information sent off, or resulting in the information not reaching the supervisor at all

III. Although the information had reached the supervisor he had failed to make himself familiar with it

Training Implications

Change programmes need to be directed at all three forms of failures mentioned above. The first will concern those who ought to supply the information, such as senior managers, wuppliers, manufacturers of plant, equipment, material etc., consultants, safety officers and so on. The second concerns improving the communications systems to ensure that all necessary information reaches the supervisor without distortion. The third will concern the training of supervisors to receive, understand and use the information, or even to seek out, the information if necessary.

XV Legislation

In 5.9% of the accident symptom occurrences not recongised (element 1.1), 24.1% of the ones the supervisors disagreed as accident symptom occurrences when pointed out (element 1.2.A), 4.3% of the ones which they supervisors did not think that they ought to deal with (element 2.1) and 4.5% of the ones which they did not think that anybody ought to deal with, the failure of legislation to stipulate requirements was cited as a contributory factor.

Although this factor influenced the majority of the stages of supervisory decision process, it was evident only in a comparatively small proportion of accident symptom occurrences. Supervisors quoted this as a reason in only a few of the accident symptom occurrences which were actually outside the scope of legislation. None of them stated that they ignored all the accident symptom occurrences which were not covered by legislation. However, some of the accident symptom occurrences that they stated were not required to be dealt with by regulations were in fact breaches of the regulations. It seems that when there is no other guidance to deciding what should be included in the safety activities and what should not, supervisors use their knowledge of legislation to define the limits.

Supervisors often stated that they found it much easier to get the workpeople to follow measures stipulated in the regulations than other measures. Also, the management was said to concentrate more on complying with the legal requirements. These factors are likely to have created a situation where 'non-stipulation in the regulations' was accepted in the site organisation as a reason for ignoring accident symptom occurrences.

<u>Training Implications</u>

As discussed in Chapter 4 a vast majority of accidents in construction sites happen in conditions where there was no breach of the regulations. It therefore seems important that a change programme should empahsise the need to adopt other measures (those not stipulated in the regulations).

For satisfactory effectiveness, it is likely that such programmes should be directed at other personnel involved with the site organisation, as well as the supervisors. In addition there is scope for training in what the legal requirements actually are, so that supervisors can capitalise on the greater willingness of their superiors and subordinates to comply with the law than to work safely per se.

8.4 Safety Role Perceptions

Although in general, the formal structure defined by the higher management of an organisation is likely to be a supervisor's main reference point for his expectations, in construction organisations the roles of most individuals seemed to be strongly influenced by negotiation and agreement and to depend upon the particular circumstances of each situation. This demanded a considerable degree of adaptation from one situation to another. As a result of the lack of clarity of responsibility and authority of individuals in construction organisations and the ease with which agreed programmes, schedules and plans could be disrupted by any of the participants, the role conception of construction supervisors appeared to be subject to a great deal of variation and uncertainty.

It was found that the presence of accident symptom occurrences in a supervisory work situation was the result of the combination of a large variety of influences. These influences were categorised under 15 headings. Discussions under section 8.3 highlighted 3 major safety role problems of supervisors. Each such problem was found to be influenced by a number of factors. In order to cope with these problems, supervisors seemed to adopt a number of ways of lowering their safety performance expectations. It is important to note that these are based on supervisors' perceptions only. The respective factors contributing to each problem and the apparent ways of coping with them are given below.

8.4.1 Safety Role Problems

Problem 1 The range and complexity of the required tasks were perceived to be beyond the supervisor. In such cases, supervisors had difficulty in recognising and/or dealing

with certain accident symptom occurrences and also tended to manage with a lower level of safety than was desirable.
The following factors were found to contribute to this problem:

i. Inadequacies in supervisory competence
ii. Lack of perceived authority
iii. Lack of information which should have been communicated to the supervisor
iv. Limitations of resources
v. Inadequacies of the safety management systems
vi. The complexity and unexpectedness of contingency situations
vii. Task overloading

Problem 2 Perceived incompatibility between the expectations of the safety role and other work roles of the supervisor. As a result, supervisors were found to raise the threshold of conditions which they categorised as accident symptom occurrences and also to decide not to respond to certain of the safety demands.
The following factors were found to lead to this:

i. Incompatible demands requiring separate and irreconcilable actions
ii. Resource limitations
iii. Presence of contingency situations
iv. Company rules, policies and practices adverse to safety
v. The power of traditional practices incompatible with safety expectations

vi. Influences of a social climate not well disposed towards maintaining a satisfactory safety level on the site.

Problem 3 Perceived conflict between different role incumbants of the site organisation concerning the safety functions of the supervisor. A major factor causing this conflict appeared to be the difference in values, norms and goals of different persons in the work situation. As a result of this conflict, supervisors were found to surrender some of their safety expectations.

The following factors were found to contribute to this problem:

i. Influences of the social climate
ii. Company rules, policies and practices
iii. Incompatible demands resulting in different work personnel allocating different priorities to safety and other work demands
iv. Traditional practice resulting in opposition from other work associates to attempts to carry out safety functions.

8.4.2 Coping with Safety Role Problems

The high degree of flexibility and discretion allowed to supervisors seemed to make it possible for them to adapt their safety role to cope with the problems described above, in a variety of ways. A reactive approach, wherein they dealt mainly with the imminent and straightforward problems, rather than following a careful and thorough-going effort to deal with all safety inadequacies was often found to be adopted. Limitations and boundaries were also imposed, on the safety role expectations of the supervisors, in the following ways.

i. Outside the boundaries of supervisory duties

Supervisors categorised a large number of safety activities as outside the boundaries of their duties. The absence of a rigid definition of functions and responsibilities, together with the high degree of discretion allowed to the supervisors seemed to enable easy adoption of this approach.

ii. Lack of authority

Supervisors surrendered authority or perceived a lack of it, thereby deciding not to perform some of the problem safety functions. Lack of a defined authority structure in many construction site organisations seemed to facilitate this.

iii. Acceptance of hazards as inevitable

Supervisors accepted certain hazards as inevitable and as natural characteristics of the construction industry, and thereby avoided taking action to deal with them.

iv. Dependence upon the individual workmen

Supervisors avoided taking actions to deal with some hazards on the claim that the individual workmen were able to cope with them and were responsible for doing so.

v. Legislation

Supervisors limited their safety activities merely to attempts to comply with the legal requirements. This enabled them to ignore a large number of accident symptom occurrences, which were not covered by legislation.

8.5 Comparison of Different Categories of Each Dimension

A number of dimensions on which supervisor/site units varied in the construction industry were discussed in Chapters 2 and 3. The category of each supervisor with respect to each of these dimensions was recorded in the field study. Section 7.2 presents the categories of each dimension and the number of supervisors belonging to each category in the study sample. The next step of the analysis examines whether there was a significant difference between the perceptions of supervisors belonging to different categories of a particular dimension.

8.5.1 The Analysis

The perception variables were divided into two groups - (a) Performance Perceptions and (b) Influence Perceptions.
(a) Performance Perceptions refer to the four stages of the flow chart, namely, recognition of an accident symptom occurrence by the supervisor, whether the supervisor thought that he ought to deal with it, whether the supervisor thought that anybody ought to deal with it, and the supervisor's knowledge of a suitable method.

The number of accident symptom occurrences on which each supervisory interview was carried out was not constant. Therefore the only score on which the performance perception of different supervisors could be compared was the percentage of the accident symptom occurrences falling into any category. For example, if the supervisor failed to recognise four out of a total of ten accident symptom occurrences on which he was interviewed, then his failure to recognise score would be 40%.

Each supervisor was given a score on each of the four performance perceptions on this basis.

(b) Influence Perceptions refer to the fifteen factors (discussed in section 8.3) identified as influencing the performance perceptions. Here too, the appropriate score for each influence factor was considered to be the percentage of the accident symptom occurrences for which the supervisor cited the particular factor as a reason for a NO answer at any stage of the flow chart. For example, if a supervisor cited resource limitations as an influencing factor in three of a total of twelve accident symptom occurrences on which he was interviewed, then his score for resource limitations would be 25%.

Thus, each supervisor belonged to one category of each of eleven dimensions, and had one score for each of four performance perceptions and fifteen influence perceptions.

The aim of the analysis was to compare the scores on each of the perception variables between supervisors belonging to different categories on each dimension of supervisory variations, to test whether there was a significant difference between categories of any dimension on the basis of any of the perception scores. The technique used was the Kruskal-Wallis one-way analysis of variance by ranks. It tests the null hypothesis that the sample categories come from the same population or from populations identical with respect to means.

The eleven dimensions of supervisory variations versus the nineteen perception variables produced a total of 209 tables.

A fortran program was specially devised to tabulate the data. A standard application program devised by computer centre staff of the University of Aston (UA30) was then used to test each table by the Krustal-Wallis technique. All the tables are not presented in the thesis due to the limit of space. Instead, the results of the test on all the 209 tabulations are presented in table 33, indicating whether the null hypothesis can be rejected or not at the 0.05 level of significance. Where it can be rejected, the highest level of significance at which the rejection is possible also is indicated. At the level of 0.05, there were nineteen significant tabulations in all.

Out of a total of 209 tables, one could expect the results of the test to be significant at 0.05 level in about ten tables and at 0.01 level in about two tables. Therefore, before accepting the statistical significance as important, an attempt was made to see if other additional evidence was present such as, whether the variations fitted a plausible explanation, a particularly high level of significance (which indicates a lower probability of occurrence and not a stronger relationship), or corroborative support from significant variations in other dimensions. In the tables of results, H is the statistic used in the Kruskal-Wallis test.

Table 33 Results of Kruskal-Wallis One-Way Analysis of Variance of Ranks

Dimensions of Supervisor/ Site Variations	Performance Perception Variables				Influence Perception Variables														
	Failure to Recognise	Did not consider that the Supervisor ought to deal with	Did not consider that anyone ought to deal with	Lack of knowledge of a suitable method	Resource Limitations	Outside Supervisory Duties	Incompatible Demands	Acceptance of Hazards	Influences of Social Climate	Tradition in the Industry	Lack of Technical Competence	Dependence upon Individual Workmen	Lack of Authority	Contingency Situation	Inadequacies of Safety Management System	Task Overloading	Company Rules and Practices	Lack of Information	Legislation
A SUPERVISOR DIMENSIONS																			
I Trade or Other Background	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	R at 0.05	NR	NR	NR
II Range of Age	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
III Range of Construction Experience	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	R at 0.05	NR
IV Range of Supervisory Experience	NR	NR	NR	NR	NR	NR	R at 0.05	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
B SITE DIMENSIONS																			
I Size of Firm	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
II Degree of Completion of Project	NR	NR	NR	NR	NR	NR	NR	NR	R at 0.05	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
III Type of Construction	NR	R at 0.05	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
IV Size of Project	NR	R at 0.01	NR	R at 0.05	NR	NR	NR	NR	NR	NR	NR	NR	R at 0.01	NR	R at 0.05	NR	NR	NR	NR
V Position of the Supervisor	R at 0.01	R at 0.05	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	R at 0.05	NR	R at 0.01	NR	NR	NR	NR
VI Type of Support Staff	NR	R at 0.05	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	R at 0.05	NR	R at 0.05	NR	NR	NR	NR
VII Type of Contract	NR	R at 0.01	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	R at 0.01	NR	R at 0.05	NR	NR	NR	NR

* NR - Not rejected
R - Rejected

8.5.2 Discussion of the Results

(A) The Supervisor Dimensions

i Trade or Other Background

There was no significant variation between the categories of this dimension with respect to any of the performance perception variables. Only one influence perception variable, namely, Task Overloading was found to vary significantly between those categories (see table 34).

TABLE 34 Trade or Other Background Versus Task Overloading

	Trade		Mean
1	Carpenter		37.96
2	Bricklayer		29.97
3	Plasterer		60.87
4	Decorator		41.87
5	Plumber		33.12
6	Labourer		23.83
7	Direct Recruit		26.90
	$H = 13.07$	$p < 0.05$	$df = 6$

The category which seems to feel task overloading as a hindrance to safety performance most, is the one with plasterer background, whereas the supervisors with labourer background seems to feel it the least. It is difficult to reason out an explanation as to why such a difference exists, particularly in the absence of an apparent logical trend. There is no significant difference with respect to the other perception variables between background categories, and there is also no significant difference in the way task overloading influences different categories in any of the other dimensions of supervisory variation. An explanation of this finding must therefore await confirmation by further studies.

ii <u>Range of Age</u>

There is no apparent difference in any of the performance perception variables or the influence perception variables with respect to different age categories.

iii <u>Range of Construction Experience</u>

There is no apparent difference between the categories of this dimension with respect to any of the performance perception variables. As regards the influence perception variables, there is only one variable, namely, Lack of Information which shows a significant variation between categories (see table 35).

TABLE 35 Range of Construction Experience Versus Lack of Information

	Construction Experience	Mean
1	Less than 10 years	52.33
2	10 to 19 years	26.54
3	20 to 29 years	33.61
4	30 to 39 years	33.92
5	40 to 49 years	45.94
6	50 and over	62.50
	$H = 12.15$ $p < 0.05$	df = 5

Apart from a comparatively high mean value for the supervisors with the least experience, there seems to be a trend in the other categories, wherein perception of the influence of lack of information increases with construction experience. Since none of the other fourteen influence variables appears to vary with construction experience, and the perception of the influence of lack of information does not appear to vary with the categories of any other dimension of supervisory variation, a level of significance of only 0.05 may have occurred by chance. It may, however, be that more experienced supervisors are more aware of the information which should be available to them. Supervisors with less than 10 years experience (comparatively new entrants), may also have had better training and/or education, and therefore be better aware of the need for information. However, it is difficult to see why their increased training and awareness should be confined to this variable alone.

iv Range of Supervisory Experience

None of the performance perception variables vary significantly with experience as a supervisor. A significant variation is noted only in the case of the fifteen influence perception variables, namely Incompatible Demands (see table 36).

TABLE 36 Range of Supervisory Experience Versus Incompatible Demands

	Supervisory Experience	Mean
1	Less than 1 year	40.17
2	1 to 4 years	28.78
3	5 to 9 years	35.75
4	10 to 14 years	44.58
5	15 to 19 years	22.31
6	20 years and over	48.06
	$H = 13.71$ $p < 0.05$	df = 5

Since there does not seem to be a logical trend in the variation, it is difficult to provide a rational explanation for this variation. In this case too, none of the other fourteen influence variables appear to vary significantly with supervisory experience, nor does the perception of incompatible demands seem to vary with any of the other dimensions of supervisory variation. An explanation of this finding must therefore await confirmations in further studies.

A Comment on Supervisory Background Variables

The above discussion seems to indicate that there are few, if any, important factors to do with the supervisory background which can be used to predict the problems which an individual supervisor will have in dealing with accident symptom occurrences. However, the range of factors measured in this study was limited, and further study might throw up significant variables.

(B) Site Dimensions

i Size of Firm

There is no significant variation in any of the performance or influence perception variables of supervisors belonging to different categories of size of firm.

ii Degree of Completion of the Project

None of the performance perception variables seem to vary significantly with this dimension. A significant variation is noted with respect to only one of the fifteen influence perception variables, namely, Influences of the Social Climate (see table 37).

TABLE 37 Degree of Completion of Project Versus Influence of Social Climate

	Percentage Completed		Mean
1	0 to 20%		21.15
2	21% to 40%		31.14
3	41% to 60%		43.45
4	61% to 80%		38.77
5	over 80%		44.36
	H = 12.23	$p < 0.05$	df = 4

This variable does not vary significantly with the categories in any other dimension. Although there is a possibility that a level of significance of 0.05 may have occurred by chance, there appears to be a trend wherein supervisors in projects with a higher degree of completion feel that the social climate influencing safety performance to a greater degree than those in projects with a lesser degree of completion. This may be because the pressures of completion targets are greater then, and because later stages of the project involve the employment of a greater variety of different groups of workmen (sometimes) a greater number of skilled workmen) with whom the supervisor must negotiate.

iii Type of Construction

None of the fifteen influence perception variables vary with this dimension. Only one of the four performance perception variables, namely, The Supervisor considering that he ought not deal with the accident symptom occurrence, shows a significant variation with the categories of this dimension. (see table 38).

TABLE 38 Type of Construction Versus Rejection of Supervisory Action

	Type of Construction	Mean
1	New Dwelling Construction	24.98
2	Work on Existing Structures	29.30
3	New Public & Commercial Buildings	39.16
4	New Works of Civil Engineering	44.96
5	New Industrial Buildings	45.44
	$H = 11.66$ $p < 0.05$	$df = 4$

This particular perception variable also varies significantly on four other dimensions (see below). The trend of supervisors rejecting action on their part for accident symptom occurrences increased in the order as indicated in table 38. This order is also one of an increasing tendency to have specialist work groups engaged on the site, and this may explain the variation. This explanation is further supported by the fact that the perception of lack of authority, although not significant, follows a similar trend (see table 39).

TABLE 39 Type of Construction Versus Lack of Authority

	Type of Construction	Mean
1	New Dwelling Construction	29.98
2	Work on Existing Structures	32.85
3	New Public & Commercial Buildings	34.87
4	New Works of Civil Engineering	42.42
5	New Industrial Buildings	42.83

iv Size of Project

There are two performance perception variables (the supervisor rejecting his own responsibility for action, and the lack of knowledge of how to deal with the symptom) and two influence perception variables (lack of authority and inadequate safety management systems) which vary significantly with this dimension (see table 40).

a) Rejection of Supervisor's Own Action. This performance perception variable also varies with four other dimensions. The trend is that, with the increase in project size, there is a tendency for the proportion of accident symptom occurrences that supervisors rejected from their own action to increase. This could be due to the reason that in larger projects, a supervisor is likely to have more activities within his section undertaken by specialists, as well as due to the presence of other staff to take responsibility for part of the activities.

b) Lack of Knowledge of a Suitable Method. There does not seem to be any trend in the variation of this variable with the size of the project. It is difficult to figure out why there should be a large difference between the 2nd and the 3rd categories of this dimension whereas the means for the other categories are similar. This performance variable does not vary significantly with any other dimension and the level of significance is only 0.05. For all these reasons, there is a reasonable possibility that this significance is a chance occurrence. An explanation of this finding must therefore await confirmations in further studies.

TABLE 40 **Significant Test Results for Size of Project**

	Size of Project	Rejection of Supervisor's Own Action	Lack of Knowledge of a Suitable Method	Lack of Authority	Inadequacies of Safety Man. Systems
	Estimated Value	Mean	Mean	Mean	Mean
1	Below £100,000	25.83	37.39	29.28	42.11
2	£100,000 to £199,999	22.41	23.32	27.47	47.38
3	£200,000 to £499,999	41.04	46.75	25.32	30.32
4	£500,000 to £999,999	40.51	37.50	48.11	29.61
5	£1 million and over	45.56	35.78	45.41	28.84
		$H = 14.91$	$H = 10.60$	$H = 17.73$	$H = 10.95$
		$p < 0.01$ df = 4	$p < 0.05$ df = 4	$p < 0.01$ df=4	$p < 0.05$ df=4

c) Lack of Authority. There is a highly significant variation in the perception of the influence of lack of authority with the size of the project. This influence variable also varies significantly with the categories of three other dimensions. The trend is that supervisors in larger projects perceived the influence of lack of authority in a larger proportion of accident symptom occurrences than those in smaller projects. This could be due to the presence of more specialists and supervisors in larger projects and so supports (a) above.

d) Inadequacies of Safety Management Systems. This influence variable also varies significantly with the categories of three other dimensions of supervisory variation. The trend is for supervisors in larger sites to perceive a lesser degree of inadequate safety management systems than those in smaller sites. This may be because safety management systems are better organised in larger sites than smaller ones. Also, on smaller sites, the supervisor is more likely to be in charge of the site and hence be more aware of the need for safety management systems.

v Position of the Supervisor

There are two performance variables (failure to recognise and, rejection of supervisor's own action) and two influence variables (lack of authority and inadequacies of safety management systems) which vary significantly with the categories of this dimension (see table 41).

TABLE 41 Significant Test Results for Position of Supervisor

Position of Supervisor	(a) Failure to Recognise	(b) Rejection from Supervisor's Own Actions	(c) Lack of Authority	(d) Inadequacies of Safety Management Systems
	Mean	Mean	Mean	Mean
1 Supervisor in charge of site	29.97	27.73	28.89	42.86
2 " " " " section	42.64	40.17	43.19	39.44
3 " " " " trade	29.32	46.18	41.75	22.71
4 Semi-supervisor	58.00	38.00	33.08	14.25
	H = 13.25	H = 9.57	H = 8.07	H = 10.95
	$p < 0.01$	$p < 0.05$ df=3	$p < 0.05$	$p < 0.01$ df = 3
	df = 3		df = 3	

a) Failure to Recognise. The variation of the degree of failure to recognise with the categories of this dimension is highly significant ($p < 0.01$), even though it does not vary significantly with the categories of any other dimension. Supervisors in charge of a site and those in charge of a trade seem to be better able to recognise accident symptom occurrences than those in charge of a section and semi-supervisors.

The better performance of the former two categories could be due to the following reasons. Supervisors in charge of a site, being the persons having overall responsibility for all work, as well as being likely to be of a higher calibre, may be more knowledgeable and better informed about the nature of hazards in most activities on the site. Supervisors in charge of a trade, being specialists in that trade are likely to be better informed and knowledgeable about the type of hazards relating to those activities.

The lower performance of the other two categories could be due to the following reasons. The calibre of supervisor in charge of a section may not be as high as that in charge of a site, and also being responsible for a section and under the direction of the man in charge, may not have the opportunity or the interest to be familiar with the nature of hazards in some activities within his section. The semi-supervisor, being even lower in the hierarchy, may not have had the opportunity or the compulsion to gain training and information about certain hazards connected with his activities.

b) Rejection of Supervisor's Own Action. This performance variable also varies significantly with the categories of four other dimensions. Supervisors in charge of a site seem to have a lesser proportion of accident symptom occurrences in this variable than the other categories. This could be due to the perception of the overall nature of their responsibility, whereas the other categories feel responsible for only part of the activities.

c) Lack of Authority. This influence variable also varies with three other dimensions. In this case too, supervisors in charge of a site seem to feel the influence of lack of authority on safety performance to a much lesser degree than the other categories. As with (b) above, this difference could be due to the recognition of his own overall authority on the part of the supervisor in charge of the site whereas there are greater limitations on the authority of the others.

d) Inadequate Safety Management Systems. This influence variable seems to vary with the position of the supervisor at a high level of significance ($p<0.01$). It also varies significantly with three other dimensions of supervisory variation. There appears to be a marked trend wherein the degree of perception of the influence of this variable decreases in the order in which the categories are given in table 41. This trend could be because, supervisors in charge of a site and those in charge of a section are more concerned with management than the others and so will be more aware of the inadequacies of safety management systems.

vi Type of Support Staff

One performance variable (rejection of supervisor's own action) and two influence variables (lack of authority and inadequacies of safety management systems) were found to vary significantly with the categories of this dimension (see table 42).

TABLE 42 Significant Test Results for Type of Support Staff

Type of Support Staff	(a) Rejection of Supervisor's Own Action	(b) Lack of Authority	(c) Inadequate Safety Man. Systems
	Mean	Mean	Mean
1 Safety Officer & Superior on Site	45.00	39.14	34.07
2 Superior only on Site	41.37	41.50	28.23
3 Neither Superior nor Safety Officer on Site	27.08	27.27	44.27
4 Visiting Supervisor	30.58	35.92	36.75
	$H = 8.39$	$H = 7.88$	$H = 9.19$
	$p<0.05$ $df = 3$	$p<0.05$	$p<0.05$
		$df = 3$	$df = 3$

a) Rejection of Supervisor's Own Action. This performance variable also varies with the categories of four other dimensions. The proportion of accident symptom occurrences perceived to be influenced by this variable seems to be increased by the presence of a superior, and further increased if a safety officer also is on the site. It seems that those supervisors expect the superior and/or safety officer to deal with some of the accident symptom occurrences. They are also the ones whose responsibilities are limited to a section or part of the activities on a site. On the other hand, categories 3 and 4 are supervisors carrying overall responsibility and therefore may consider that they ought to take action in the case of a larger proportion of accident symptom occurrences.

b) Lack of Authority. Perception of lack of authority as an influencing factor on safety performance also varies significantly with the categories of three other dimensions. Supervisors with a superior and/or safety officer on site perceive the influence of lack of authority on safety to a greater extent than the other two categories. This, as with (a) above, is likely to be due to the limitations of perceived authority on those supervisors who are in charge of only a section or a group of activity.

c) Inadequate Safety Management Systems. This variable also varies significantly with the categories of three other dimensions. The group of supervisors who perceive the influence of this variable the least, are those with only the superior on the site. It is possible that they are the ones least concerned with management, being in charge of a limited section or a group of activities and having no safety officer on site to advise them on safety management systems, and so are least aware of the inadequacies of safety back up.

vii Type of Contract

In this case too, one performance variable (Rejection of supervisor's own action) and two influence variables (lack of authority and inadequacies of safety management systems) were found to vary significantly with the categories (see table 43).

TABLE 43 Significant Test Results for Type of Contract

Type of Contract	(a) Rejection of Supervisor's Own Action	(b) Lack of Authority	(c) Inadequacies of Safety Management Systems
	Mean	Mean	Mean
1 BOQ and SOR contracts	42.06	40.95	29.68
2 Lump-sum contracts	31.50	20.04	39.77
3 Re-imbursable cost contracts	26.62	32.75	44.08
4 Direct Labour Works	14.70	38.70	50.40
	$H = 12.20$	$H = 11.76$	$H = 8.97$
	$p<0.01$	$p < 0.01$	$p < 0.05$
	df = 3	df = 3	df = 3

a) Rejection of Supervisor's Own Action. A highly significant variation ($p<0.01$) is noted between categories in the case of this performance variable. It also varies significantly with three other dimensions. The lowest mean is found in supervisors of direct labour works, which could be a reflection of the greater control and responsibility of these supervisors on the activities. The absence of sub-contractors and other groups to whom a part of the responsibility may be allocated in other types of contract also could be a contributing factor. However, it would be useful to examine the reasons for the differences between different types of contract by further studies.

b) <u>Lack of Authority</u>. The variation of the perception of lack of authority as affecting safety performance is also noted to be highly significant ($p < 0.01$). This variable also varies significantly with three other dimensions. Supervisors on projects under lump-sum contracts seem to feel it the least. Further studies to examine this variation and its causes could be useful for a clearer understanding of the reasons and effects.

c) <u>Inadequate Safety Management Systems</u>. This influence variable also varies significantly with three other dimensions. There seems to be a trend wherein, the degree to which it is perceived increases in the order of the categories as given in table 43. Direct labour supervisors seem to feel the inadequacies of safety management systems the most. Here again, there appears to be a need for further studies to examine the variation between categories in detail.

8.5.3 General Comments on Site Variables

There seem to be a number of site variable dimensions that are important to the ways in which supervisors perceive both performance and influence variables.

<u>Ability to recognise</u> accident symptom occurrences appears to vary significantly with the position of the supervisor. Supervisors in positions carrying the need and opportunity to be better informed and knowledgeable about their work activities (eg those in charge of a site or a trade) appear to be better able to recognise than those in positions where the need and opportunity to obtain such knowledge and information are less

(eg. those in charge of a section and semi-supervisors).

The degree to which supervisors rejected their own actions to deal with accident symptom occurrences seem to vary significantly as follows:

it increases with increase in tendency to employ specialist work groups (eg. in the order of type of construction shown in table 38);

it increases with increase in project size;

it is lower where the supervisor is in a position of overall responsibility (eg. those in charge of the entire site);

it is higher where some of the management responsibilities are handled by a superior on the site and still higher if a safety officer is also available on the site;

it is less in types of contract which allow greater control to the supervisor (eg. direct labour works).

The degree of perception of the effects of lack of authority on safety performance seems to vary significantly as follows:

greater in larger projects;

less in the cases where the supervisory position carries overall authority (eg. those in charge of the site);

greater where there is a superior on the site and still greater where there is a safety officer on the site in addition;

and less in the case of lump-sum contracts.

The degree of perception of the effects of social climate on safety performance appears to vary significantly as follows:

it increases with increase in the degree of completion of the project;

it decreases with increase in the size of project;

it is higher when the supervisor's position carries a higher degree of management responsibility;
it is lower where some of the management functions are carried out by a superior and there is a lack of specific safety advice (eg. a superior on the site but not a safety officer);
and it is higher in the case of direct labour works.

It is possible that the dimensions - size of project, position of supervisor, type of support staff, and type of contract, themselves are inter-related ie not independent. An examination of whether they are inter-related, and if so, the nature of the relationship, using a very large sample of sites, is therefore likely to be immensely useful for predicting supervisory perceptions as regards safety. In view of the limited number of sites used, such an analysis was not attempted in this study.

It is important to note that the decision of supervisors not to deal with accident symptom occurrences themselves, tends to be related positively to perception of lack of authority and negatively to perception of inadequacies of safety management systems. Two types of explanations are plausible for this relationship.

(i) Supervisors in the respective categories perceive an actual difference in authority and inadequacies of safety management systems.

(ii) Supervisors in different categories choose either to reject authority or to blame inadequacies of safety management systems, whichever is convenient to that category, to justify the rejection of actions by themselves to deal with the accident symptom occurrences.

The above discussed dimensions and variables, together with an appreciation of the nature of their inter-relationships seem particularly important in the identification of problems as well as designing and undertaking action programmes to deal with those problems.

CHAPTER 9

APPLICATION OF THE METHOD FOR DETAILED STUDIES

- PART 3 OF THE STUDY -

9.1 Introduction

Part 2 of this research highlighted 15 factors which, according to the perceptions of the supervisors, influenced their behaviour towards site safety. How these factors give rise to 3 different types of safety role problems, and the ways in which some of the factors were used by supervisors to lower the level of safety performance as a means of coping with those problems (ref. Section 8.4) will be discussed in section 10.1.2. The need for individual investigations of supervisors in the context of their particular work and organisational situations as a basis for describing their safety role and training needs was re-iterated throughout this thesis. It was also argued that the perceptions of the other role incumbents of the organisation would play an important part in such investigations.

The present part of the study was designed to gain insight into the ways in which safety role problems manifested themselves in the case of particular supervisors in their own particular set-ups, and the expectations of other role incumbents in the site organisation towards the safety role of those supervisors. The aim of this exercise was threefold -

i. to test the applicability of the method in the case of detailed investigations;

ii. to examine whether or not the conclusions of part 2 of the study were supported by detailed investigations; and

iii. to examine the degree and implications of any variations in the expectations of other role incumbents.

9.2 The Study

The study consisted of 4 detailed case studies in which the interviewing was extended to the supervisor's superiors as well as the safety officers.

9.2.1 Selection of the Sites and Supervisors

A major practical constraint on this part of the study was that no guarantee could be given to the supervisors that the information would not be discussed with anyone else in the firm. Their co-operation had to be gained without promising confidentiality of the information. It was considered that the most convenient method of achieving this was by presenting the study as a part of a company exercise. Such a presentation carried the added advantage of providing the opportunity to examine the effectiveness of the method in the case of a company investigation, which would be the most likely form of a specific investigation. Permission to interview each supervisor's superiors and Safety Officer was also necessary. This part of the research therefore demanded a much higher degree of co operation and involvement from the firms than was required from those used in part 2. In addition, supervisor/site units with a wide variety of construction activities, and variations in the dimensions which were found to be important in section 8.5 were considered most suitable for this investigation, to ensure the coverage of as wide a spectrum as possible.

At the end of a large number of enquiries, three construction firms were found who agreed to co operate to the extent required for this investigation. The firms were guaranteed that any reports on the investigation would not carry information likely to divulge their identity. Three projects,

varying in type of construction, size of project and type of contract were selected, one from each firm.
Four supervisors occupying varying positions and type of support staff were selected, two from one site and one each from the other two. Comparative studies between categories were not envisaged for this part of the study. The nature and size of this sample was therefore considered appropriate and adequate for a detailed investigation.

9.2.2 Procedure Adopted

Advance notice of the investigation and the researcher's visit together with a request for co operation was conveyed to the supervisor (and the Site Agent if different) by the firm's head office. Further details were to be discussed on the site. On arrival at the site, the researcher explained the detail of the proposed investigation to the supervisor/ Site Agent, during which period it was possible to build a good rapport. In each case, the supervisor was the subject of the first interview.
In every interview, the researcher first explained the list of accident symptoms and then the list of factors found to influence each stage of the interview flow-chart. A description of the field investigation in part 2 of the research was also given. The steps followed in the subsequent field interview were similar to those in part 2 (explained in section 7.3) with the exception that for a NO answer at any stage of the flowchart, in seeking reasons from the supervisor, questions were asked specifically with respect to every possible influencing factor as found in part 2 (eg. 11 in the case of failure to recognise, 15 in the case of rejection

from the supervisor's own action etc.), to check if the supervisor thought that any of them were relevant on that particular occasion. It is therefore likely that more reasons were elicited per supervisor than in the earlier investigations. It could be argued that this method would encourage supervisors to elevate to the status of reasons factors which were in reality not important as influences on their behaviour. It was felt that this danger was compensated for by the richness of data generated, and that the distortions could be minimised by weighting the importance of the reasons according to the number of times that they were cited across the range of accident symptoms. An attempt was made to cover the entire supervisory section, so as to include accident symptoms with respect to all the activities taking place in the section at the time of the visit.

The results of the supervisory interviews relating to each accident symptom occurrence were then listed in preparation for interviewing the supervisor's superiors (Site Agent and/ or Project Manager), and the Safety Officer. These latter series of interviews were based primarily on the results of the supervisory interviews. First, the interviewee had explained the method of investigation used, including the table of accident symptoms, the interview flowchart and the factors found to influence supervisory behaviour at each stage of the flowchart. Their comments with regard to the suitability and adequacy of the method in relation to the objectives of the study were also requested. This was followed by a detailed interview on the supervisory reasons for NO answers at different stages of the flowchart with respect to each accident symptom. The accident symptoms were treated one at a time. After a description of the accident symptom occurrence, the response of the supervisor at each stage of the flowchart was examined against the supervisory reasons for that response. The aim of the interview was to check whether each supervisory reason for a response was acceptable to the interviewee as appropriate under the circumstances. If a reason was accepted, it was taken to imply that he considered no change was necessary as regards the supervisor, whereas if unaccepted, that he considered a supervisory change as necessary to correct the situation.

9.2.3 Results of the Investigation

The three firms which took part in this study were named firm A, firm B, and firm C. One project from each firm was used and the projects too were named A, B, and C respectively. The Safety Officers and Project Managers were interviewed in all three projects. In project B, the supervisor studied was the person in charge of the site. Therefore, only two site agents, those in projects A and C were interviewed as supervisor's superiors. Two supervisors from project A were used. They were named supervisors A1 and A2. The details of these supervisors and sites are presented in Table 44.

TABLE 44 The Details of Supervisors and Sites Used in Part 3 of the Study

Supervisor/Site Variables	Supervisor A1	Supervisor A2	Supervisor B	Supervisor C
1. Trade or other background	Carpentry & Joinery	Bricklaying	Carpentry & Joinery	Improved Labourer
2. Age	42 yrs	55 yrs	45 yrs	38 yrs
3. Construction Experience	26 yrs	37 yrs	30 yrs	21 yrs
4. Supervisory Experience	12 yrs	7 yrs	21 yrs	3 yrs
5. Size of firm - Total number employed	About 300 employees		About 1500 employees	About 700 employees
6. Degree of completion of project	About 60%		About 35%	About 25%
7. Type of construction	Industrial construction - New and work on existing structures		New Dwelling Construction	New Works of Civil Engineering Construction
8. Size of project - Estimated value	About £450,000		About £175,000	About £620,000
9. Position of the supervisor	In charge of a trade	In charge of a section	In charge of the site	Semi-Supervisor
10. Type of support staff	Superior on site but not Safety Officer		Neither superior nor Safety Officer on site	Superior on site but not Safety Officer
11. Type of contract	Bill of Quantities Contract		Lump Sum Contract	Re-imbursable Contract Cost

A total of 26 accident symptoms were encountered in the four supervisory sections during the investigations. These are given below:

(1) Lack of stability

(2) Unsuitable construction

(3) Unsuitable loading

(4) Improper stacking

(5) Protruding objects

(6) Accessible edges

(7) Obstructions

(8) Harmful construction material

(9) Falling Objects

(10) Lack of fitness of equipment

(11) Persons using inappropriate methods

(12) Persons using unsound construction items

(13) Inappropriate layout

(14) Persons failing to adopt control measures

(15) Persons assinged to the function of diagnosing hazards less than adequate

(16) Location of hazard indicators less than adequate

(17) System of transport unsuitable

(18) System of mechanical handling unsuitable

(19) System of operation unsuitable

(20) System of manual handling unsuitable

(21) System of diagnosing and monitoring hazards less than adequate

(22) System of hazard indication less than adequate

(23) Facilities provided for preventive measures less than adequate

(24) System of adopting preventive measures less than adequate

(25) Construction of corrective measures less than adequate

(26) Systems adopted for control measures less than adequate.

There were a number of cases where the same accident symptom was encountered more than once, although under different circumstances. For example, altogether four different conditions of 'lack of stability' were noted. As a result of these multiple occurrences, the total number on which supervisors were interviewed came up to 49. For convenience of presentation in the tables, each of the 26 accident symptoms was represented by the corresponding number in the above list. A second occurrence of any one of these was termed by the number accompanied by suffix 'a' a third by 'b', a fourth by 'c' and a fifth by'd'. Thus, the four occurrences of 'lack of stability' were termed (1),(1)a, (1)b, and (1)c.

The accident symptom occurrences encountered in the four supervisory sections are separately presented in table 45.

TABLE 45

Accident Symptoms on which the Supervisors were Interviewed

Supervisor A1	Supervisor A2	Supervisor B	Supervisor C
(1)	(1)b	(2)a	(1)c
(1)a	(6)	(4)a	(3)
(2)	(6)a	(7)c	(3)a
(4)	(7)	(12)a	(5)b
(5)	(7)a	(15)	(5)c
(5)a	(7)b	(16)a	(6)b
(10)	(8)	(17)	(7)d
(11)	(13)		(9)
(11)a	(14)	(22)a	(10)a
(12)	(19)	(25)	(14)a
(16)	(21)	(25)a	(20)
(18)			(24)
(22)			(26)a
(23)			
(26)			
TOTAL 15	11	10	13

Detailed data pertaining to each interview are presented in appendix 2. They include tables indicating supervisory reasons at each stage of the flowchart and whether the reasons were acceptable or not to the supervisors' superiors and Safety Officers. Tables 46 to 64 present a summary of these data in the text. The first column of each table indicates the number of accident symptom occurrences for which a particular reason was given. Unless a statement at the bottom of a table indicates otherwise, all accident symptom occurrences accepted by Safety Officer were amongst those accepted by Project Manager which in turn were amongst those accepted by Site Agent. Since there were more than one reason for a NO answer in most accident symptom occurrences, the total is greater than the number of accident symptoms in that category. Data pertaining to each supervisor are first given in separate tables.

<u>Supervisor A1</u>

Total number of accident symptom occurrences (a.s.o's) = 15

Table 46 - Failure to recognise (9 a.s.o's)

Table 47 - Rejection of supervisor's own action (11 a.s.o's)

Table 48 - Rejection of anybody's action (5 a.s.o's)

Table 49 - Lack of knowledge of a suitable method (6 a.s.o's)

Table 50 - Other reasons (4 a.s.o's)

<u>Supervisor A2</u>

Total number of a.s.o's = 11

Table 51 - Failure to recognise (6 a.s.o's)

Table 52 - Rejection of supervisor's own action (7 a.s.o's)

Table 53 - Rejection of anybody's action (1 a.s.o.)

Table 54 - Lack of knowledge of a suitable method (3 a.s.o's)

Table 55 - Other reasons (3 a.s.o's)

Supervisor B

Total number of a.so.'s = 10

Table 56 - Failure to recognise (3 a.s.o's)

Table 57 - Rejection of supervisor's own action (5 a.s.o's)

Supervisor B did not reject action by anybody for any of the a.s.o's in his section

Table 58 - Lack of knowledge of a suitable method (1 a.s.o.)

Table 59 - Other reasons (5 a.s.o's)

Supervisor C

Total number of a.s.o's = 13

Table 60 - Failure to recognise (8 a.s.o's)

Table 61 - Rejection of supervisor's own action (9 a.s.o's)

Table 62 - Rejection of anybody's action (2 a.s.o's)

Table 63 - Lack of knowledge of a suitable method (4 a.s.o's)

Table 64 - Other reasons (4 a.s.o's)

The aggregated results with respect to each influencing factor are presented in tables 65 to 79. It should be noted that since supervisor B himself was the Site Agent, in his case the number of supervisory reasons were also recorded under the number accepted by the Site Agent.

Table 65 - Limitations of resources

Table 66 - Outside supervisory duties

Table 67 - Incompatible demands

Table 68 - Acceptance of hazards as inevitable

Table 69 - Influences of the social climate

Table 70 - Tradition in the industry

Table 71 - Lack of technical competence

Table 72 - Dependence on the individual workmen

Table 73 - Lack of authority

Table 74 - Contingency situations

Table 75 - Inadequacies of the safety management

Table 76 - Task overloading

Table 77 - Company rules, policies and practices

Table 78 - Lack of information

Table 79 - Absence of legislation

Tables 80 to 83 present the same data aggregated according to the 15 influencing factors by each supervisor together with the numbers accepted by the other parties.

Table 80 - Supervisor A1

Table 81 - Supervisor A2

Table 82 - Supervisor B

Table 83 - Supervisor C

TABLE 46 Failure to Recognise A1

Number of accident symptom occurrences	Supervisor's Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
5	Outside the supervisor's duties	4	3	1
2	Acceptance of hazards as inevitable	2	0	0
3	Tradition in industry	2	1	0
4	Lack of technical competence	3	2	0
3	Dependence upon individual workmen	3	3	1
2	Safety management system inadequacies	2	2	2
1	Lack of information	1	1	0
20	TOTAL	17	12	4

TABLE 47 Rejection of Supervisor's Own Action - Supervisor A1

Number of accident symptom occurrences	Supervisor's Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
4	Resource limitations	2	2	0
7	Outside supervisory duties	4	4	2
4	Incompatible demands	4	2	0
3	Acceptance of hazards as inevitable	3	2	0
4	Tradition in industry	3	2	0
4	Lack of technical competence	3	2	2
4	Dependence upon individual workmen	4	3	2
2	Safety management system inadequacies	2	2	2
2	Company policy	0	0	0
2	Not covered under legislation	2	0	0
36	TOTAL	27	19	8

TABLE 48 Rejection of Anybody's Action - Supervisor A1

Number of accident symptom occurrences	Supervisor's Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
3	Acceptance of hazards as inevitable	3	2	0
2	Tradition in the industry	2	2	0
4	Dependence upon individual workmen	4	3	0
9	TOTAL	9	7	0

TABLE 49 Lack of Knowledge of a Suitable Method - Supervisor A1

Number of accident symptom occurrences	Supervisor's Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
4	Outside supervisory duties	4	3	2
5	Lack of technical competence	3	3	2
2	Safety management system inadequacies	2	2	2
3	Lack of information	3	3	3
14	TOTAL	12	22	9

TABLE 50 Other Reasons for the Presence of Accident Symptom Occurrences - Supervisor A1

Number of accident symptom occurrences	Supervisor's Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
1	Resource limitations	1	1	0
2	Incompatible demands	2	2	0
1	Influences of the social climate	1	0	0
2	Contingency situations	2	2	0
2	Task overloading	2	2	0
8	TOTAL	8	7	0

TABLE 51 Failure to Recognise - Supervisor A2

Number of accident symptom occurrences	Supervisor's Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
2	Outside supervisory duties	0*	2	2
2	Acceptance of hazards as inevitable	1	1	0
1	Lack of technical competence	0	0	0
3	Dependence upon individual workmen	2	2	0
2	Contingency situations	2	0	0
2	Safety management system inadequacies	2	1	2
2	Company practice	0	0	0
1	Lack of information	0	0	0
1	Lack of legislation	1	0	0
16	TOTAL	8	6	4

* Safety Officer and Project Manager accepted the reason in both cases whereas Site Agent did not

TABLE 52 Rejection of Supervisor's Own Action - Supervisor A2

Number of accident symptom occurrences	Supervisor's Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
2	Resource limitations	2	1	0
2	Outside supervisory duties	1*	1	0
1	Incompatible demands	1	0	0
2	Acceptance of hazards as inevitable	1	1	0
1	Influences of the social climate	1	0	0
1	Lack of technical competence	0	0	0
4	Dependence upon individual workmen	2	2	0
3	Contingency situations	3	2	0
1	Safety management system inadequacies	1	1	1
2	Company practice	0	0	0
1	Lack of legislation	1	0	0
20	TOTAL	13	8	1

* The accident symptom occurrence accepted by Project Manager is different from that accepted by Site Agent

TABLE 53 Rejection of Action by Anybody - Supervisor A2

Number of accident symptom occurrences	Supervisor's Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
1	Acceptance of hazards as inevitable	1	1	0
1	Dependence upon individual workmen	1	1	0
1	Lack of legislation	1	0	0
3	TOTAL	3	2	0

TABLE 54 Lack of Knowledge of a Suitable Method - Supervisor A2

Number of accident symptom occurrences	Supervisor's Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
1	Outside supervisory duties	0*	1	1
1	Lack of technical competence	0	0	0
2	Safety management system inadequacies	2**	1	2
2	Company practice	0	0	0
1	Lack of information	0	0	0
7	TOTAL	2	2	3

* Although both Safety Officer and Project Manager accepted the reason, the Site Agent did not

** One accident symptom occurrence accepted by the Safety Officer was not accepted by the Project Manager

TABLE 55 Other Reasons - Supervisor A2

Number of accident symptom occurrences	Supervisor's Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
1	Influences of the social climate	1	1	0
2	Contingency situations	2	0	0
1	Task overloading	1	0	0
4	TOTAL	4	1	0

TABLE 56 Failure to Recognise - Supervisor B

Number of accident symptom occurrences	Supervisor's Reasons	Number accepted by Project Manager	Number accepted by Safety Officer
1	Outside supervisory duties	1	0
1	Lack of technical competence	0	0
1	Dependence upon individual workmen	0	0
1	Contingency situations	1	0
1	Lack of information	0	0
5	TOTAL	2	0

TABLE 57 Rejection of Supervisor's Own Action - Supervisor B

Number of accident symptom occurrences	Supervisor's Reasons	Number accepted by Project Manager	Number accepted by Safety Officer
3	Resource limitations	1	1
2	Outside supervisory duties	2	0
1	Incompatible demands	1	1
3	Dependence upon individual workmen	2	0
1	Task overloading	1	0
10	TOTAL	7	2

NO REJECTIONS FROM ACTION BY ANYBODY

TABLE 58 Lack of Knowledge of a Suitable Method - Supervisor B

Number of accident symptom occurrences	Supervisor's Reasons	Number accepted by Project Manager	Number accepted by Safety Officer
1	Lack of technical competence	0	0
1	Lack of information	0	0
2	TOTAL	0	0

TABLE 59 Other Reasons - Supervisor B

Number of accident symptom occurrences	Supervisor's Reasons	Number accepted by Project Manager	Number accepted by Safety Officer
2	Resource limitations	1	1
1	Incompatible demands	1	1
3	Contingency situations	1	0
1	Safety management system inadequacies	1	1
1	Task overloading	0	0
8	TOTAL	4	3

TABLE 60 Failure to Recognise - Supervisor C

Number of accident symptom occurrences	Supervisor's Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
3	Outside supervisory duties	3	3	2
1	Incompatible demands	0	0	0
1	Acceptance of hazards as inevitable	0	0	0
1	Tradition in industry	1	1	0
1	Lack of technical competence	0	0	0
2	Dependence upon individual workmen	2	2	0
1	Contingency situations	0	0	0
3	Safety management system inadequacies	2	2	2
1	Lack of legislation	0	0	0
14	TOTAL	8	8	4

TABLE 61 Rejection of Supervisor's Own Action - Supervisor C

Number of accident symptom occurrences	Supervisor's Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
1	Resource limitations	1	0	0
4	Outside supervisory duties	3	3	2
1	Incompatible demands	1	0	0
1	Acceptance of hazards as inevitable	0	0	0
1	Influences of the social climate	0	0	0
1	Lack of technical competence	0	0	0
2	Dependence upon individual workmen	2	2	0
2	Lack of authority	2	1	1
3	Safety management system inadequacies	2	2	2
1	Lack of legislation	0	0	0
17	TOTAL	11	8	5

TABLE 62 Rejection of Action of Anybody - Supervisor C

Number of accident symptom occurrences	Supervisor's Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
1	Acceptance of hazards as inevitable	0	0	0
2	Dependence upon individual workmen	2	2	0
3	TOTAL	2	2	0

TABLE 63 Lack of Knowledge of Suitable Method - Supervisor C

Number of accident symptom occurrences	Supervisor's Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
3	Outside supervisory duties	2	2	2
3	Lack of technical competence	0	0	0
3	Safety management system inadequacies	2	2	2
9	TOTAL	4	4	4

TABLE 64 Other Reasons - Supervisor C

Number of accident symptom occurrences	Supervisor's Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
2	Resource limitations	2	0	0
1	Influences of the social climate	1	0	0
1	Contingency situations	0	0	0
1	Task overloading	0	0	0
5	TOTAL	3	0	0

TABLE 65 Limitations of Resources

Supervisor	Number of Supervisory Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
A1	5	3	3	0
A2	2	2	1	0
B	5	5	2	2
C	3	3	0	0
TOTAL	15	13	6	2

TABLE 66 Outside Supervisory Duties

Supervisor	Number of Supervisory Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
A1	16	12	10	5
A2	5	1	4	3
B	3	3	3	0
C	10	8	8	6
TOTAL	34	24	25	14

TABLE 67 Incompatible Demands

Supervisor	Number of Supervisory Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
A1	6	6	4	0
A2	1	1	0	0
B	2	2	2	2
C	2	1	0	0
TOTAL	11	10	6	2

TABLE 68 Acceptance of Hazards as Inevitable

Supervisor	Number of Supervisory Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
A1	8	8	4	0
A2	5	3	3	0
B	0	0	0	0
C	3	0	0	0
TOTAL	16	11	7	0

TABLE 69 Influences of the Social Climate

Supervisor	Number of Supervisory Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
A1	1	1	0	0
A2	2	2	1	0
B	0	0	0	0
C	2	1	0	0
TOTAL	5	4	1	0

TABLE 70 Tradition in the Industry

Supervisor	Number of Supervisory Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
A1	9	7	5	0
A2	0	0	0	0
B	0	0	0	0
C	1	1	1	0
TOTAL	10	8	6	0

TABLE 71 Lack of Technical Competence

Supervisor	Number of Supervisory Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
A1	13	9	7	4
A2	2	0	0	0
B	2	2	0	0
C	5	0	0	0
TOTAL	22	11	7	4

TABLE 72 Dependence on Individual Workmen

Supervisor	Number of Supervisory Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
A1	11	11	9	3
A2	8	5	5	0
B	4	4	2	0
C	6	6	6	0
TOTAL	29	26	22	3

TABLE 73 Lack of Authority

Supervisor	Number of Supervisory Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
A1	0	0	0	0
A2	0	0	0	0
B	0	0	0	0
C	2	2	1	1
TOTAL	2	2	1	1

TABLE 74 Contingency Situations

Supervisor	Number of Supervisory Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
A1	2	2	2	0
A2	7	7	2	0
B	4	4	2	0
C	2	0	0	0
TOTAL	15	13	6	0

TABLE 75 Inadequacies of the Safety Management Systems

Supervisor	Number of Supervisory Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
A1	6	6	6	6
A2	5	5	3	5
B	1	1	1	1
C	9	6	6	6
TOTAL	21	18	16	18

TABLE 76 Task Overloading

Supervisor	Number of Supervisory Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
A1	2	2	2	0
A2	1	1	0	0
B	2	2	1	0
C	1	0	0	0
TOTAL	6	5	3	0

TABLE 77 Company Rules, Policies and Practices

Supervisor	Number of Supervisory Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
A1	2	0	0	0
A2	6	0	0	0
B	0	0	0	0
C	0	0	0	0
TOTAL	8	0	0	0

TABLE 78 Lack of Information

Supervisor	Number of Supervisory Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
A1	4	4	4	3
A2	2	0	0	0
B	2	2	0	0
C	0	0	0	0
TOTAL	8	6	0	3

TABLE 79 Absence of Legislation

Supervisor	Number of Supervisory Reasons	Number accepted by Site Agent	Number accepted by Project Manager	Number accepted by Safety Officer
A1	2	2	0	0
A2	3	3	0	0
B	0	0	0	0
C	2	0	0	0
TOTAL	7	5	0	0

TABLE 80 Supervisor A1 Data Aggregated According to Each Influencing Factor

Supervisory Reasons	Supervisor	Site Agent	Project Manager	Safety Officer
1 Resource Limitations	5	3	3	0
2 Outside Supervisory Duties	16	12	10	5
3 Incompatible Demands	6	6	4	0
4 Acceptance of Hazards as Inevitable	8	8	4	0
5 Influences of the Social Climate	1	1	0	0
6 Tradition in the Industry	9	7	5	0
7 Lack of Technical Competence	13	9	7	4
8 Dependence upon the Individual Workman	11	11	9	3
9 Lack of Authority	0	0	0	0
10 Contingency Situations	2	2	2	0
11 Safety Management System Factors	6	6	6	6
12 Task Overloading	2	2	2	0
13 Company Rules, Policies and Practices	2	0	0	0
14 Lack of Information	4	4	4	3
15 Lack of Legislation	2	2	0	0
TOTAL	87	73	56	21
PERCENTAGE	100	84.0	64.4	24.1

TABLE 81 Supervisor A2 Data Aggregated According to Each Influencing Factor

Supervisory Reasons	Supervisor	Site Agent	Project Manager	Safety Officer
1 Resource Limitations	2	2	1	0
2 Outside Supervisory Duties	5	1	4	3
3 Incompatible Demands	1	1	0	0
4 Acceptance of Hazards as Inevitable	5	3	3	0
5 Influences of the Social Climate	2	2	1	0
6 Tradition in the Industry	0	0	0	0
7 Lack of Technical Competence	2	0	0	0
8 Dependence upon the Individual Workman	8	5	5	0
9 Lack of Authority	0	0	0	0
10 Contingency Situations	7	7	2	0
11 Safety Management System Factors	5	5	3	5
12 Task Overloading	1	1	0	0
13 Company Rules, Policies and Practices	6	0	0	0
14 Lack of Information	2	0	0	0
15 Lack of Legislation	3	3	0	0
TOTAL	49	30	19	8
PERCENTAGE	100	61.2	38.8	16.3

TABLE 82 Supervisor B Data Aggregated According to Each Influencing Factor

Supervisory Reasons	Supervisor	Project Manager	Safety Officer
1 Resource Limitations	5	2	2
2 Outside Supervisory Duties	3	3	0
3 Incompatible Demands	2	2	2
4 Acceptance of Hazards as Inevitable	0	0	0
5 Influences of the Social Climates	0	0	0
6 Tradition in the Industry	0	0	0
7 Lack of Technical Competence	2	0	0
8 Dependence upon the Individual Workman	4	2	0
9 Lack of Authority	0	0	0
10 Contingency Situations	4	2	0
11 Safety Management System Factors	1	1	1
12 Task Overloading	2	1	0
13 Company Rules, Policies and Practices	0	0	0
14 Lack of Information	2	0	0
15 Lack of Legislation	0	0	0
TOTAL	25	13	5
PERCENTAGE	100	52	20

TABLE 83 Supervisor C Data Aggregated According to Each Influencing Factor

Supervisory Reasons	Supervisor	Site Agent	Project Manager	Safety Officer
1 Resource Limitations	3	3	0	0
2 Outside Supervisory Duties	10	8	8	6
3 Incompatible Demands	2	1	0	0
4 Acceptance of Hazards as Inevitable	3	0	0	0
5 Influences of the Social Climate	2	1	0	0
6 Tradition in the Industry	1	1	1	0
7 Lack of Technical Competence	5	0	0	0
8 Dependence upon the Individual Workman	6	6	6	0
9 Lack of Authority	2	2	1	1
10 Contingency Situations	2	0	0	0
11 Safety Management System Factors	9	6	6	6
12 Task Overloading	1	0	0	0
13 Company Rules, Policies and Practices	0	0	0	0
14 Lack of Information	0	0	0	0
15 Lack of Legislation	2	0	0	0
TOTAL	48	28	22	7
PERCENTAGE	100	58.3	45.8	14.8

9.3 The Analysis and Discussion

This part of the study collected a great deal of information concerning the supervisors and safety problems of the sites investigated. This material is capable of being subjected to many forms of analysis and examination. In particular, the data clearly reveal a large number of details useful for determining the respective supervisors' specific job behaviour objectives concerning safety. However, the analysis and discussion presented in this section are limited to the examination of the objectives stated in section 9.2.

9.3.1 Applicability of the Method for Specific Investigations

The aim of investigating a particular supervisor in his own particular set up is to understand the dynamics underlying his behaviour in that situation. This understanding is essential for planning an effective intervention to improve performance by training and/or introducing other change programmes. Studies of social scientists are usually designed to understand and explain organisational behaviour in general. It has often been pointed out (eg. Jenks 1970) that there is a paucity of applicable procedures based on the findings of such studies for diagnosing particular organisational problems. One objective of this part of the study was to test the applicability of a slightly modified form of the method of field investigations used in the general study to specific investigations.

In Chapter 5, the following three criteria were identified as crucial for the success of the method in its application in a specific study.

Criterion I   It should effectively highlight safety problems present in an on-going construction situation at any particular time, and also identify safety training objectives.

Criterion II It should effectively highlight a supervisor's perceptions with regard to the factors likely to influence his performance and behaviour relating to those problems. These should provide guidance as to the ways in which training objectives could be determined and met most effectively.

Criterion III The information generated should be meaningful to managers and change agents. It should enable them to diagnose the determinants underlying the supervisor's behaviour and thereby identify his training needs and his likely response to other changes.

A discussion of the method against each criterion is presented in the following paragraphs.

Criterion I   The table of accident symptoms was applied successfully to identify safety problems on sites to use as stimuli for supervisory interviews in part 2 of the study. The validity of accident symptoms as indicators of safety shortfalls on sites and their meaningfulness and acceptability to supervisors were also established in parts 1 and 2 of the study. The effectiveness of the table of accident symptoms in the investigations of all the four supervisors in part 3 of the study was further evidence of its validity in specific studies.

In the case of each supervisor, the accident symptom occurrences, together with the performance replies provided clear indicators for the job behaviour objectives concerning safety. For example, when a supervisor failed to recognise an accident symptom occurrence which he ought to have recognised, then the objective would be to train him to recognise the various forms of that accident symptom which he is likely to encounter. Similarly, if he rejected dealing with an accident symptom occurrence himself, which he ought to deal with, then the objective would be to train him in a more acceptable definition of the boundaries of his responsibility and so on.

In addition, the table of accident symptoms was found meaningful and acceptable to the supervisors' superiors and safety officers who were interviewed - an essential feature in view of the fact that they are the most likely users of the method in specific studies.

On the basis of the above evidence, the method may be considered adequate on Criterion I above.

<u>Criterion II</u> The 15 factors identified as influencing supervisors' behaviour towards accident symptoms in part 2 of the study were used as a check-list to diagnose their effect on the supervisors in part 3 of the study. Here too, supervisors found it possible to relate the factors easily to the specific circumstances concerned, thereby permitting the investigation of the influence of all possible factors with respect to each supervisory decision. In this connection the large extent of relevant information generated itself is evidence of the effectiveness of the method.

The factors indicated by a supervisor to influence his behaviour with respect to each safety training objective identified provide a clear guidance as to the most effective ways in which those objectives could be met. For example, when a supervisory reason for failing to recognise an accident symptom occurrence was that it was outside the supervisor's duties, then the training would need to include making those supervisory duties clear to him and so on.

The method may therefore be considered to be sufficiently effective on the criterion II above.

Criterion III As was the case with the accident symptoms, the supervisors' superiors and the safety officers interviewed all found the 15 factors perceived by supervisors to influence their safety behaviour to be meaningful. They found it easy to understand the supervisors' reasons and compare those reasons with their own expectations. This fact was considered to indicate an adequate effectiveness of the method as regards criterion III.

9.3.2 Further Examination of the Findings of Part 2 (Chapter 8)

The detailed studies in this part of the research were found in general to support the conclusions in part 2. Those conclusions were broadly related to the method of investigation, safety role problems of the supervisor, his ways of coping with those problems and their implications for supervisory training. This section presents a further discussion of the same in the light of the investigations in part 3 of the study.

The Method

The nature of accident symptoms found in each supervisor's section at the time of the visit indicate that there was a substantial difference between the safety needs of the four supervisory sections studied (see table 45). There was not a single accident symptom type that was common to all the four supervisory sections. Only one type was common to each pair of A1A2, A2B, and BC; four common to A1C and A2C; and five to A1B. However, in each of these cases, where an accident symptom type was common to any two supervisors, there was a considerable difference between the responses of those supervisors with respect to the common accident symptom type (see appendix 2). For example, in the case of the only accident symptom type common to supervisors A1 and A2, (who were working on the same site), namely, "lack of stability", A2 recognised it, whereas A1 failed to do so. Although both rejected supervisor's own action, only one of a total of 5 reasons was common and so on. These differences indicate a wide degree of variation between safety training objectives for the four supervisors studied.

This variation is further evidence that there is a vital need for individual investigations in order to achieve an effective identification and monitoring of the safety training needs of supervisors. The method for individual investigations was developed on the basis of the findings in part 2. The effectiveness of this method was discussed in section 9.3.1 above.

Safety Role Problems

Section 8.4 identified three major problems perceived by supervisors as obstacles in taking steps to deal with accident symptom occurrences. Some ways in which they were found to cope with these problems by lowering the expected level of safety were also suggested. A further examination of these in the light of the information generated by detailed studies is presented in the following paragraphs.

(a) Range and Complexity of the Tasks Beyond the Supervisor

Each of the four supervisors investigated found the range and/ or complexity of the tasks required for dealing with some accident symptom occurrences in the respective sections beyond him. Discussions in Chapter 8 suggested that solutions to different manifestations of this problem were likely to involve a balance between a number of measures in varying degrees, of which supervisory training is only one. This is further supported by the wide variation in the degree to which supervisors' superiors and safety officers considered the supervisory reasons acceptable, thereby indicating the existence of a difference of opinion amongst them as to the degree of supervisory and non-supervisory changes considered appropriate (see section 9.3.3).

(b) Incompatibility Between Safety and Other Work Demands

The wide range of disparity between the supervisor's superior and safety officer with regard to the degree of acceptance of supervisory reasons (tables 46 to 83) appears to uncover a root cause underlying incompatibilities perceived by supervisors.

Safety requirements would be largely specified by safety officers, whereas the basis for other functional requirements of supervisors would be created and defined mainly by site agents and to a lesser degree by project managers (whose influence in most cases is likely to be indirect). In the absence of a proper fit between the expectations of the supervisors' superiors and safety officers, it is not surprising that supervisors find some parts of each of the two sets of demands incompatible. In general, there seems to be a greater difference between the expectations of site agents and safety officers than those of project managers and safety officers. Being the person who is in direct control of and in constant contact with the supervisor, the site agent's expectations are likely to have the dominating influence.

(c) Perceived Conflict Between Different Role Incombents Concerning Safety Functions of the Supervisor

The high degree of disagreement found amongst the supervisors' superiors and safety officer on the supervisory safety functions is also likely to present itself to the supervisor in the form of a conflict between those role incombents. On the sites studied, those different expectations seem prima facie evidence of the reality of the perceived conflict.

Coping with Safety Role Problems

Findings in part 2 of the study suggested that supervisors imposed limitations and boundaries on their expected safety duties as a means of coping with the safety role problems discussed above. The results of part 3 seem to provide further evidence to support this view. Some of the supervisory reasons for the presence of accident symptom occurrences were not acceptable to any of the others interviewed, although the degree of acceptability varied. Those reasons may therefore be considered as limitations imposed by the supervisor himself. In view of the greater degree of agreement between supervisors and site agents, the possibility that the site agents themselves may have subscribed to the imposition of such limitations in the case of some of the other reasons (which were acceptable to the site agents and not to the others) also cannot be ruled out.

9.3.3 Variations in the Expectations of Other Role Incumbents

It should be pointed out that, in view of the limited extent of data gathered in this part of the study, the results must be looked at with great care. The following discussion therefore merely suggests some trends and their possible implications on the basis of this data.

The high degree of variation found amongst the supervisor, his superiors and the safety officer (as indicated in tables 46 to 83), further supports the view that in certain cases, supervisory safety functions had not been clearly defined and/or effectively communicated by the respective organisations. It is therefore not surprising that supervisors perceived a considerable degree of uncertainty with regard to their safety role expectations. However, there seems to be a generally consistent pattern in the variation observed. A steady decrease in the degree of acceptance of supervisory reasons was found from site agent to project manager to safety officer, in the vast majority of the cases.

Tables 46, 51, 56 and 60 (failure to recognise) and tables 47, 52, 57 and 61 (rejection of supervisor's own action) all indicate the general steady fall mentioned above. Site agents seem to accept a large number of supervisory reasons for failure to recognise as well as rejection of supervisor's own action, thereby suggesting the need for a considerable extent of non-supervisory changes to improve site safety. Safety officers on the other hand, seem to expect a far greater degree of supervisory action and ability to recognise accident symptom occurrences, and hence suggest a need for a very high degree of supervisory changes. Project managers expectations appear to be between those of the site agents and safety officers.

Supervisory reasons for rejection of action by anybody were totally unacceptable to the safety officers in all the cases (tables 48, 53, 62).

Safety officers therefore seem to expect some action to deal with accident symptom occurrences under all circumstances. Reasons for rejection of anybody's action were accepted to a greater extent by site agents and to a lesser extent by project managers. Therefore, line management, and in particular site management seem to accept some accident symptom occurrences as inevitable. Although, safety officer B accepted three of the "Other Reasons" by the supervisor (table 59), safety officers A and C accepted none (tables 50, 55, 64). The responses of site agents and project managers were very similar to their respective responses in the case of "Rejection of Action by Anybody". There seems to be a fundamental difference between the approach of safety officers and that of line management. The former appears to demand unconditional safety under all circumstances whereas the latter expect to disregard some types of safety problems in certain circumstances of day to day site activities.

Comparatively, a very high degree of agreement between supervisors' superiors and safety officers was found with respect to the reasons for "Lack of knowledge of a Suitable Method of Dealing with Accident Symptom Occurrences" (tables 49, 54, 58 and 63). This may be considered as indicating a general recognition of the need for the availability of other sources of expertise with regard to safety in many site operations, ie. the supervisor cannot be expected to have the knowledge to deal with all the safety problems on site. This weakens the importance of supervisory training as an accident control strategy.

Tables 65 to 83, presented under the headings of influencing factors, all indicate the general trend discussed above. In addition, the following specific observations seem relevant. However, the limitations of the size of the sample need to be borne in mind in allocating importance to these observations. They are particularly useful as points worthy of further investigation.

1 Certain influencing factors which may be acceptable to site agents and project managers as supervisory reasons seem altogether unacceptable to safety officers. Example are, "Acceptance of Hazards as Inevitable" (table 68), "Influences of Social Climate" (table 69), "Tradition in the Industry" (table 70), "Contingency Situations" (table 74) and "Task

Overloading" (table 76). Safety officers seem to consider that in all these cases supervisory actions are essential to improve the situation and hence that change strategies should be directed at the supervisor.

II "Absence of Legislation" as a supervisory reason (table 79) seems in general unacceptable to both project manager and safety officer but acceptable to site agents. Head office management therefore seem to possess a healthier attitude to safety legislation than site management.

III "Company Rules, Policies and Practices" (table 77) seem in general unacceptable as reasons to all the three parties. Each one being a part of the senior management, this response may indicate their reluctance to blame the company policies, rules and practices for which they themselves share the responsibility.

IV Comparatively a high degree of agreement was found between the site agent and the project manager with regard to the factor "Outside the Boundaries of Supervisory Duties" (table 66).

V A high degree of agreement between the supervisor, site agent and project manager were found in the expectations regarding "Dependence upon Individual Workmen" (table 72).

VI Common agreement of a considerable degree between the supervisor, his superiors and safety officer was found in the case of "Safety Management System Factors" (table 75). It is interesting that this influence was also found to show significant variation between site categories as a reason for supervisors' rejection of their own action (section 8.5) This may be interpreted as a general dissatisfaction with safety back-up systems.

VII Aggregated data in tables 80 to 83 indicate clearly the pattern of variation amongst each supervisor, his superiors (on site and head office) and the safety officers.

It appears from the above that a distinction exists between the approach of the line management and that of the safety officer towards the safety functions of the supervisor. The former seem to view the expected degree of safety effort of supervisors as variable according to the circumstances, whereas the latter seems to expect his unconditional devotion to safety.

In general, the closer the association of a superior with the supervisory position, the greater seems to be the acceptance of supervisory reasons. One possible explanation is that the process of socialization may overlap to a greater extent in the case of those who are closely associated.

A second explanation is that a closer association may provide a better understanding of the practical realities of the supervisory job and a resultant appreciation of a need for trade-offs between safety and other criteria. Another explanation is that supervisory behaviour and expectations are influenced to a greater extent by his closest superior and hence the greater concurrence observed. Safety officers, being not directly involved with the day to day site activities may fail to understand the practical difficulties of achieving unconditional safety on sites and thereby expect a greater commitment to safety from supervisors than is realistic. Such expectations also can have the effect of undermining the safety officers credibility in the eyes of the site staff and thereby reduce his influence on their attitudes and behaviour. It is also possible that the site management view production as their main responsibility and safety as a subordinate function to that responsibility rather than a part of it.

The variation of expectations amongst different role incumbents has some important implications with respect to planning an intervention to improve site safety.

Firstly, it seems essential to establish defined supervisory safety functions as regards different types of accident symptoms for each organisation. A clearly defined organisational policy in this respect should enable a change agent to divide the needs, identified in a specific study, into appropriate categories (eg supervisory, non-supervisory etc.) - an essential pre-requisite for planning an effective change programme.

Secondly, training (or introducing other changes to) the supervisor alone, is not likely to solve the problems of incompatibility and conflict, the major causes of which seem external to him. In this connection, the achievement of a reasonable degree of agreement amongst other role incumbents of the organisation with regard to the safety role of the supervisor seems essential. Detailed studies on individual sites, similar to those in this part of the study appear to reveal the differences, thereby helping to identify where changes would be necessary. It would also provide the basis for achieving agreement on the supervisory and non-supervisory changes needed amongst those role incumbents, so as to ensure their co-operation in the implementation of the change programme as well as its subsequent application on site.

Lastly, it seems necessary that a supervisory training programme be accompanied by appropriate training of other role incumbents of the organisation. Their acceptance of the objectives of the supervisory training programme would be crucial for that training to remain effective.

9.4 Summary

This chapter deals with the third part of this study, which was set up with the objectives of testing a method for detailed case studies, for further investigating the conclusions of the second part of the study and examining the acceptability of supervisory role expectations to other role incumbents of the organisation. The investigation consisted of studies of four supervisors in three construction sites from three different firms, and included interviews of supervisors' superiors as well as safety officers.

The method was found suitable and adequate for specific detailed investigations, on the basis of three criteria considered appropriate. The study provided further evidence to support the conclusions of part 2, in general. A considerable degree of variation was found amongst the expectations of the supervisor, his superiors and the safety officer with respect to the safety functions of the supervisor. Efforts to close the gaps between those expectations were found important for the success of a supervisory safety training programme.

CHAPTER 10

GENERAL DISCUSSION, CONCLUSIONS AND SUGGESTIONS FOR FURTHER STUDIES

10.1 General Discussion

This section presents an examination of the implications of the results of the research in relation to its stated objectives.

The main objectives were:

i. to develop and test a suitable method of investigating the safety role of the first line construction supervisor with reference to his training needs

ii. to describe that role and identify areas in which an improvement would be necessary and/or beneficial

iii. to understand the factors influencing that role and to highlight the characteristics of the industry and its organisation which affect the role.

An examination of the implications of the above, for the scope of supervisory influence on safety, and for the training that supervisors needed to carry that influence into optimum effect was also envisaged.

10.1.1 The Method

A fundamental feature of the safety role of the construction supervisor emerging from this study, which represents a formidable problem in describing that role, is the ever-changing nature of the functions of a supervisor and the work environment in which those functions are carried out. In view of the large variations and diversities found in the nature, environment, labour force and work climate of different sites and areas of sites, and the importance of the effects of contextual factors on supervisory behaviour, the safety functions carried out by a particular supervisor varied from one situation to another. A high degree of adaptation on his part was found necessary to cope with these changes.

A definition of inflexible safety goals, and desirable and undesirable behaviour was found inappropriate. This study therefore, rejected attempts to find general descriptions of the safety role of the construction supervisor. It was clear that individual cases had to be investigated separately to find the role most appropriate to that case. Developing and testing a method for studying individual cases was therefore considered important and viable. Similarly, as regards safety training needs, it became clear that each organisation had to define for itself what safety needs <u>should be</u> met be training of supervisors to suit its own case. This study concentrated on finding out what training needs <u>could be</u> met by training of supervisors.

The Research Method

The technique of investigation in this research adopted an exploratory or discovery approach. The main aim of the exercise was to uncover as many important factors as possible, not to measure or compare. The basic strategy found suitable was to derive a set of general categories of characterisits from the details of a wide variety of situations and to use those categories as a tool for highlighting the specific characteristics of a particular situation. Thus, a list of accident symptoms in table 5 (page 140) was generated from the details of accident reports, and this list was used in turn as an instrument for identifying their specific occurrences on sites to use as stimuli for focussed interviewing. Similarly, the detailed information gathered by way of the interviews in part two of the study was categorised into 15 factors (Chapter 7) which were found to influence the safety role of the construction supervisor, a number of those being relevant to each stage of the supervisory decision process. In the detailed investigations of part-three of the study, those factors were used as a check list to identify the specific influences present in each particular supervisor's part of the site.

In the derivation of the table of accident symptoms from accident reports, it was considered that the descriptions provided were adequate evidence for a scientific investigation. It is possible that these reports were subject to various forms of concious or unconcious errors and different degrees of bias caused by limitations and interests of the investigators and reporters concerned. However it is likely that much of the bias will have been cancelled out by the use of a large number of accident reports and companies, and since the purpose of the exercise was to generate a list of categories and not to measure their relative importance the overall bias is likely to be unimportant. Also, since the main purpose of the table was to highlight a set of safety inadequacies acceptable and meaningful to the supervisor it seemed appropriate that the table should be derived from accident descriptions made by site personnel. The successful use of the table of accident symptoms to generate relevant information over a wide variety of supervisor/site units in the focussed interviews was considered an adequate demonstration of the acceptability and the meaningfulness of the list to supervisors, and its wideranging applicability. This was further supported by part three of the study, in which supervisors' superiors and Safety Officers also found the list acceptable and meaningful.

The demonstration of the meaningfulness of accident symptoms to supervisors and other important role incumbents of the organisation has further implications that are immensely important to supervisory training. Being general descriptions of the safety goals of a supervisory work area, the table of accident symptoms also specifies the safety objectives in terms of work situational characteristics which are clear to the supervisors as well as to others who are likely to be involved in the decisions concerning their training. The table thereby can be considered to provide a comprehensive general description of fundamental training objectives (prevention and removal of the occurrence of accident symptoms) towards the achievement of which safety training should be directed.

It was found that in the site interviews in part two, supervisors related their perceptions and evaluations of accident symptom occurrences to several aspects of the situation. This is evident from the diversity of the factors identified as influencing those perceptions and evaluations. Also, several criteria were used in each case (as indicated by the fact that several different reasons were given for each NO answer) with varying degrees of priority. Another important feature evident from the analysis and discussion in section 8.2 is that different supervisors gave answers based on different frames of reference to the same questions. However, the flexible nature of the field study and the freedom allowed to the individual to give his own reasons without being guided or restricted, was able to cope with these differences and produce valid data.

The aim of the supervisory interviews in part two was to uncover the influences inhibiting achievement of site safety objectives and an effective safety role, as perceived and experienced by the supervisor. Here too, supervisors were expected to provide insight into their own behaviour and reasoning as well as into organisational influences in a scientific manner. The extent to which they did so is difficult to estimate. Although the researcher was entirely independent of the subjects' vested interests in every way, there is the possibility that the answers may have been consciously or subconciously slanted in the direction of social approval. However, this study being primarily concerned with generating broad categories rather than the specificities and their significance, it was considered that the effect of any such bias on the final outcome would be minimal.

It is also unlikely that the subjects conciously took all the factors they cited into account in a particular decision, but rather gave them as explanations in retrospect. It is not expected that the subjects adopted an approach in accordance with the flowchart or took into consideration all the factors highlighted under each decision stage as a routine. The usefulness of the flowchart is as a means of systematisation for the purposes of data collection, discussion and design of change programmes. In other words the factors provide an indication of the possible influences, which are uppermost in supervisors' minds, not a description of the actual influences from moment to moment.

The extent and diversity of the information collected from supervisors in this study demonstrated that the site supervisor was an excellent source of information for a study on site safety. In view of the key position occupied by him in a site organisation, this is not surprising. However, supervisors seemed to consider that a large number of factors contributing to the presence of accident symptom occurrences on sites were not their responsibility. There appeared to them to be a high degree of influence from a number of other parties within and outside the site upon the safety role of the supervisor and actions taken with regard to accident symptom occurrences on sites. A considerable number of accident symptom occurrences were also found to require expertise and information beyond the supervisor's grasp. The rejection of responsibility may be seen as a natural self defence enabling the supervisor to survive among the heavy and conflicting demands of a construction site. It is clear, however, that this rejection is not just an abherration of the supervisors. The site agents in part 3 of the study accepted a high percentage of the rejections of supervisory action as justified. The lack of clearly laid down responsibilities also encouraged this buck passing approach to safety by all parties. For all these reasons, the degree of influence that the supervisor is able to exercise towards improving site safety seems to be questionable, in spite of his key position.

<u>The Method Developed for Individual Studies</u>

The effectiveness of a method of investigation is obviously dependent on the objectives of that investigation. In this case, the objective was to investigate the safety role of the supervisor with reference to his training needs. Three criteria were considered essential for the successful achievement of that objective. They are.

(a) the method should effectively highlight safety problems in an ongoing construction situation at any particular time, and also identify safety training objectives;

(b) it should effectively highlight a supervisor's perceptions with regard to the factors likely to influence his performance and behaviour relating to those problems; and

(c) the information generated should be meaningful to managers and change agents, and should enable them to diagnose the determinants underlying the supervisor's behaviour and thereby identify his training needs as well as his likely response to other changes.

The method developed in this research for individual studies consist of two major characteristics

i. The list of accident symptoms derived in part 1 (table 5 page 140)

ii. The flowchart used in part two (page 128) together with the factors found to influence each stage of the flowchart (Tables 19 to 24, Pages 217 to 223).

Part three of this study demonstrated a form of application of the method in specific site investigations as well as verifying the effectiveness of the method on the above mentioned criteria. These criteria therefore define what the method can achieve.

Accident symptoms were considered as indicative of failures to achieve the site safety objectives. Their use as the central stimuli for focussed interviews was based on the conception that they represented gaps between the actual situation and the desired situation. However, it needs to be appreciated that the conditions recognised and used as accident symptom occurrences by any investigator would depend upon his own perceptions, evaluations and judgements. The values and beliefs of the investigator therefore play an important role in this process. A cut-and-dried definition of "an accident symptom occurrence" which can be used by any investigator in a standard form is not possible. This is a limitation imposed by the need for flexibility of the technique to make it adaptable to the variation from one situation to another. The personal influence of the investigator therefore, is a decisive factor that cannot be isolated from the process of diagnosing accident symptoms. However, it was found that the technique was robust, in that very largely the same factors were identified using accident symptom occurrences belonging to each of the four situational components - work setting, provision, personnel and system.

As indicated in Table 18, any particular accident symtpom occurrence can follow any of the 15 different paths in this evaluation process. It is evident that in view of the different frames of reference used by supervisors in answering the questions (section 8.2), obtaining complete information on an accident symptom occurrence is possible only if the full sequence of a flowpath is covered. The path followed will indicate the supervisory responses at each stage. In view of the availability of a number of interdependent approaches to dealing with a safety problem in an organisation (discussed in Chapter 4), the choice of which supervisory responses it would be appropriate to change in a particular case, must be a management policy decision that needs to be undertaken on the basis of a wider understanding of the organisation. For example, in the case of certain accident symptom occurrences, recognition by the supervisor may not be necessary if the company finds it more appropriate to have someone else (such as the Safety Officer, a superior, a specialist, etc.), point them out to him effectively. In such cases, what is important as far as the supervisor is concerned is that he should accept the accident symptom as a real one when it is pointed out by such persons, not that he should recognise it. Similarly, the supervisor may not need to know the method of dealing with an accident symptom occurrence if it is found more appropriate that it be dealt with by someone else.

In section 8.5, a method of comparing performance as well as the effects of different influencing factors between categories of supervisor and site characteristics on the basis of the supervisor's own perceptions was demonstrated. By and large, the background of the supervisor did not seem to provide clues for predicting safety problems or anticipating possible measures appropriate for improving site safety. However, in certain categories of site dimensions, there seemed important variables. For example, supervisors' perception of the effects of lack of authority and inadeqacies of safety management systems, together with the degree to which they rejected their own responsibility seemed to be more marked in some sites than in others.

In part 3 of the study, a wide degree of variation was found amongst the expectations of supervisors, their superiors and Safety Officers with regard to the safety functions of the supervisor. A co-ordination of these expectations seems essential if the problems of incompatibility and conflict are to be avoided. The need for a clear organisational policy concerning supervisory safety functions in any particular site organisation therefore appears to be a vital pre-requisite to identifying supervisory safety training needs and other change programmes. A major aim of such a policy would be to provide a set of rules to guide managers, change agents etc. in their decision making. The table of accident symptoms provides a useful list of headings under which such a policy could be expressed in detail in terms of contextual factors. Accident symptoms relating to the particular site activities, when properly evaluated, can be taken to set the safety objectives of that site. An appropriate safety organisation would then be one directed at effectively inhibiting their occurrence.

A method of field investigation similar to the one used in part 3 of the study could effectively reveal any deviations or gaps in the supervisor's performance and expectations. In a constantly changing situation, the method will also be useful for monitoring to see if the policy is being effectively carried out.

10.1.2 Safety Role of the Supervisor and Factors Influencing that Role

Role is defined as the expected behaviour of the occupant of a position within a group. It is related to a position and not an individual. Although there can be differences in the behaviour of different individuals in the same position, the basic role pattern is derived from the position. Role is also not limited to the expectations of any component category of a group but is a composite of the expectations of all the members of that group.

This research was limited to investigating the safety aspects of the role of the first line supervisor from the perspective of identifying his training needs. It was therefore based on critical conditions relating only to safety and not to other performance criteria. The central feature determining individual behaviour is a person's own perceptions and expectations. Therefore, especially in view of the training interest, the study was centred on the perceptions of the supervisor relating to factors influencing his behaviour. It is important to bear in mind that the method and the findings of this research relate mainly to those aspects of the safety role of the supervisor which are important for his training needs.

Three sources are normally involved in determining a role in an organisation.

(a) Formal job descriptions, which also describe duties, responsibilities, authority, etc.

(b) The individual himself, by his own perceptions, expectations and interpretations of how he ought to behave

(c) Other members of the organisation who project their expectations through interpersonal relations.

These three role determinants are briefly discussed in the following.

(a) Formal Role Prescriptions

The absence of a specific job description covering most of the safety functions of the supervisor seemed a common feature in construction site organisations. Negotiation and inter-personnel agreement on the basis of the particular circumstances appeared to be a widespread practice. Lack of implementation of a clear management policy concerning supervisors' safety responsibilities and the nature and degree of their authority was found to give rise to uncertainty amongst supervisors as well as a wide degree of variation amongst the expectations of supervisors, their peers and others. This condition was further aggravated by the presence of a number of different groups of operatives, the nature of whose relationships to the supervisors' organisation varied widely. It also seemed to enable the supervisor to lower his own safety role expectations in order to cope with some of his safety role problems. A clear definition of the expectations of the management with respect to the safety role of the supervisor in the site organisation, therefore, seemed important.

(b) Perceptions of the Individual

Percpetions and expectations of supervisors as regards their safety functions were studied by examining their reasons for shortfalls in safety performance. This approach was adopted in view of the training needs perspective where those shortfalls represented objectives for a change programme and the reasons provided insight into ways of achieving those objectives.

The study highlighted the fact that any efforts to improve safety performance of supervisors will need to take into account the following 3 major role problems experienced by supervisors:

Problem 1 - Supervisors were found to experience a lack of ability to cope with the range and complexity of the tasks required.

Problem 2 - Supervisors were found to experience a high degree of incompatibility between the expectations of the role of safety and that of other work requirements, which were said to require separate and irreconcilable courses of action. In such cases, whether the safety functions were carried out or not depended on the relative priority allocated to safety.

Problem 3 - Supervisors were found to experience a great deal of conflict between different role incumbents of the organisation with regard to supervisory safety functions. In such cases, they neglected some of the safety functions.

Supervisors were found to impose boundaries and limitations to their own safety role expectations, partly as a means of coping with the above mentioned problems, in a number of ways. Absence of a defined set of safety responsibility and authority, together with the considerable degree of flexibility and discretion allowed to supervisors seemd to permit them to exercise these limitations.

Supervisors perceived the influence of 15 factors on their safety performance. The implications of these for supervisory training will be discussed in section 10.1.3. In general, different categories of supervisors reported the influence of these factors to a similar extent. Therefore, supervisory characteristics did not seem to provide dimensions important for indicating different degrees of perception of these factors, i.e. in a specific investigation, it seems necessary to check for all the factors equally, irrespective of the category of the supervisor under investigation. However, some significant variations in supervisory perceptions were found between certain site categories (section 8.5). Further studies into these may well provide indicators for predicting safety problems or change programmes on the basis of these site characteristics.

(c) Expectations of Other Role Incumbents

The expectations of supervisors' superiors and Safety Officers were investigated in a limited number of specific studies only, and the investigation was limited to checking whether the supervisory reasons given at different stages of the flowchart were acceptable or not to them. A considerable degree of lack of concurrence was found amongst supervisors, their superiors and safety officers with respect to the expectations of supervisory functions. A major cause of this difference is likely to be the absence of a clear definition of those functions by the organisations. However, there seems to be a clear pattern in this variation.

The degree of acceptance of supervisory reasons, in general, decreased from site agent to project manager to safety officer. It is likely that the site agent, in view of his position influenced the supervisor's expectations most. Also, both are stationed on the site and are likely to have gone through a similar process of socialisation. Therefore the basis for their expectations may have been similar to each other's and different from those of the project manager and the safety officer who were head office based and therfore isolated from the practical realities and pressures of site operations. The very high degree of disagreement of Safety Officers with supervisors suggests the explanation that the supervisors may have considered safety functions as ancilliary to production functions rather than as a part of those whereas Safety Officers could have been pre-occupied with Safety and have expected supervisors to pay attention to achieve safety in preference to their other duties.

In the sites studied in part 3 of the study, there was evidence to suggest that the problems of incompatibility and conflict perceived by the supervisors may have been enhanced and in certain cases even caused, by the incompatibilities and conflicts between the expectations of their superiors and the respective safety officers. There was also evidence of the Site Agents themselves subscribing to supervisors' impostion of limitations to their safety duties in order to cope with safety role problems.

In view of the potential influence of the expectations of other role incumbents of the site organisation on supervisory behaviour towards site safety, it seems important that a supervisory training programme is accompanied by appropriate measures to ensure that those expectations are complementary to that training.

10.1.3 Implications for Supervisory Training

Implications for training of supervisors, arising out of different stages of this research were discussed in the respective chapters. The present section aims to draw them together under a single heading.

This research demonstrated that the supervisor's ability to recognise accident symptom occurrences and his knowledge of ways of dealing with them were not alone sufficient to ensure that the symptoms did not occur on sites. A large variety of factors in the work environment were found to inhibit the successful application of such knowledge. They highlighted the importance of the training of personnel in the organisation other than the supervisor, as well as the importance of taking a variety of measures other than training, in order for any supervisory training to remain effective. These factors were discussed in detail in section 8.3. Their implications for supervisory training seem to come under three basic categories. Firstly, the pre-requisiteswhich need to exist in the organisation for a successful identification and implementation of supervisory safety training needs. Secondly, the supervisory safety training needs themselves. Thirdly, the back up measures which are necessary for that training to remain effective. These are re-iterated in the following paragraphs under the headings of the 15 factors influencing performance.

I. Resource Limitations

Pre-requisites - Allocation of sufficient and suitable resources necessary for site safety in advance.

Adoption of measures to ensure that resources are made available when necessary.

Supervisory Training Needs - Training in the supervisory duties towards the allocation, supply, storage, maintenance etc. of certain resources (eg. construction material and equipment in general and material and equipment essential for safety in particular).

Training to ensure that the resources are handled and used effectively and efficiently so as to avoid the occurrence of accident symptoms.

Back up Measures - Ensuring that other parties concerned with the setting up and implementation of appropriate systems for the allocation, supply and maintenance and use of the resources function adequately.

II. Outside the Boundaries of Supervisory Duties

Pre-requisites - A clear and explicit policy as regards the responsibility structure of the site organisation with respect to its safety objectives.

Supervisory Training Needs - Training in the boundaries and extent of the supervisor's responsibilities and those of others with whom he would interact.

Back up measures - Ensuring that other members of the organisation have a reciprocal understanding of the safety responsibility structure.

III. Incompatible Demands

Pre-requisites - In the process of planning and organising the activities of the workplace and work demands, ensuring that other functional requirements are compatible with maintaining an accident symptom free site. Realistic policy to guide allocation of priorities.

Supervisory Training Needs - Training in the supervisory duties towards achieving the above pre-requisites, and also training the adoption of suitable procedures with minimum risk if and when incompatabilities do occur.

Back-up Measures - Adoption of measures to ensure that other parties concerned perform adequately to reduce incompatibilities and to minimise risks when they occur.

IV. Acceptance of Hazards as Inevitable

Pre-requisite - A firm policy with respect to all types of hazards which may be encountered on the site.

Supervisory Training Needs - Training of the supervisor in understanding of accident causes and control measures with the objective of lowering the threshold of the degree of hazards acceptable and of exercising greater supervision towards the same objective.

Back up Measures - Training of others in the organisation to lower the threshold of the degree of hazards acceptable to them.

V. Influences of the Social Climate

Pre-requisites- A proper understanding amongst all site personnel as to their desired behaviour towards the safety needs of the site and a work organisation conducive to that behaviour.

Supervisory Training Needs - Training of the supervisor on ways of obtaining cooperation from other members of the organisation to promote safety even in conditions of adverse social climate and motivating others towards safety. Training in interpersonal skills may be appropriate here.

Back up Measures - The social climate on a construction site being the result of the beliefs and attitudes of a wide variety of people involved with the organisation and their interaction, programmes to motivate personnel other than the supervisor.

VI. Tradition in Industry

Pre-requisites - A strong commitment by the organisation to change well established traditional practices if necessary for the achievement of its safety objectives.

Supervisory Training Needs - Training of the supervisor to question and, if appropriate, overcome his own tendency to follow traditional practices in cases where they are found to be detrimental to safety, and change over to safer ways of working, as well as to influence others towards the same goal.

Back up Measures - The changes may have to include a very broad programme covering a wide spectrum of the industry over a long period. Although the supervisory training content of such a programme would be vital to its success, it may still be only a small fraction of a total programme.

VII. Lack of Technical Competence

Pre-requisite - A clear definition of the safety functions of the supervisor, in order to establish areas in which supervisory competence is necessary.

Supervisory Training Needs - The above established areas will constitute the major training needs of the supervisor. In addition to theoretical knowledge, and skill, training to include successful application of those under ptactical site conditions.

Back up Measures - In cases where supervisory competence was deemed unnecessary on the grounds that others were better placed to solve the problems, provision of measures to ensure that the alternative arrangements were effective and efficient.

VIII. Dependence Upon Individual Workmen

Pre-requisites - A clear establishment of the cases where certain categories of operatives may be depended on to cope with hazards in their activities - e.g. categories of specialist contractors, skilled craftsmen etc. and a definition of areas over which supervisors could exercise surveillance.

Supervisory Training Needs - Training supervisors need to be able to make a correct decision as to when operatives could be trusted to work safely and training in the recognition of significant deviation from safe practice on the part of all staff that they supervised.

Back up Measures - Proper selection, training etc. of those categories of operatives who would be depended on to cope with hazards to ensure that they would be competent to do so.

IX Lack of Authority

Pre-requisites - Definition of a clearer structure of authority in the organisation in general and the degree and boundaries of supervisory authority in particular with respect to site safety, including those in contractual agreements and relationships between groups.

Supervisory Training Needs - A clear understanding by the supervisor, of the nature and extent of his authority with regard to safety aspects of the activities, and their relationships as well as those of other work associates.

Back-up Measures - A similar understanding amongst other role incumbents of the organisation with respect to its authority structure as regards safety.

X Contingency Situations

Pre-requisites - Measures to reduce the number and gravity of contingency situations, such as suitable planning, plan implementation etc.

Supervisory Training Needs - Training of supervisors in their functions to minimise contingencies as well as to ensure that if and when contingency situations do occur, they are handled with the minimum of risks.

Back-up Measures - Similar training of others who are involved with activities concerning minimising of contingencies and coping with them.

XI Safety Management System Factors

Pre-requisites - The implementation of an adequate and effective system for the management of safety on the site.

Supervisory Training Needs - Gaining a proper understanding of the system and ability to contribute towards its successful implementation.

Back-up Measures - Other measures (eg. training of others, adequate supply of resources etc.) to ensure the effective implementation of the system continually.

XII Task Overloading

Pre-requisites - In view of the high degree of fluctuation of supervisory workload, a proper distribution of functions and responsibilities of the supervisor to ensure that the workload does not exceed his ability to cope.

Supervisor Training Needs - Training of the supervisor in suitable planning of his own work and activities in his section, in seeking out safety problems during periods of lower workload, and in selecting suitable priorities so as to minimise risks if and when overloading does occur.

Back-up Measures - Provision of means of reducing supervisory workload (eg. sharing, making additional staff available etc.) during stages where it is likely to be beyond the coping limit.

XIII Company Rules, Policies and Practices

Pre-requisites - Vetting of rules, policies and practices established for work activities on site to ensure that they are not detrimental to safety.

Supervisory Training Needs - Imparting a clear understanding of the correct rules, policies and practices of the organisation to supervisors.

Back-up Measures - Similar training of other parties of the organisation.

XIV Lack of Information

Pre-requisites - Provision of an efficient system of communication of safety information.

Supervisory Training Needs - Training to receive, understand and even seek-out information where necessary. For example, in the case of unfamiliar substances information concerning their hazards and necessary precautions may have to be sought out in certain occasions, before they are handled, stored, used etc.

Back-up Measures - Measures to ensure that those who are responsible for the supply and transmission of information relating to safety of operations, materials, equipment etc. carry out that responsibility effectively.

XV Absence of Legislation

Pre-requisites - Implementation of a firm and explicit policy of the organisation to keep the workplace free of accident symptom occurrences whether they constitute a breach of the regulations or not.

Supervisory Training Needs - Training of supervisors to follow the above mentioned policy in practice, as well as to gain a clear understanding of the legal requirements. For example, requirements of the Health and Safety at Work Act 1974 go well beyond compliance with the specific regulations.

Back-up Measures - Similar training and/or instruction to other members concerned.

It is clear from the above, that the problems involved a wide variety of aspects of the organisation. Determining safety training needs of an individual supervisor, therefore, cannot be a self contained activity. It has to be an integral part of a larger programme which also evaluates those wider activities. Definition of safety objectives and change programmes to achieve them were found to involve many compromises and a balancing of goals, functions and priorities. Dealing with factors identified on a site in an effective manner was found to involve a combination in different degrees, of a variety of measures in addition to supervisory training and training of other members besides the supervisor. What would be an appropriate balance between them in a particular case would depend upon its specific circumstances.

As was discussed before, each supervisory job on construction sites is unique to a large extent. A large proportion of the behavioural and training objectives therefore have to be drawn up on an individual basis. For this reason, the drawing up of a standard list of objectives was rejected as a research objective in favour of the development of a method to enable individual organisations to draw up objectives to suit their own cases.

Individual studies which are able to identify the safety objectives for the whole of a supervisor's work area in terms of the particular site characteristics was found an essential pre-requisite to planning supervisory training in different site organisations.

A distinction needs to be drawn between new entrant training and training of experienced supervisors. Training objectives for new entrants would need to involve the safety content of the whole of the job, whereas those for experienced supervisors would involve only the areas where an improvement is found desirable due to identified difficulties in coping with the problems. In both cases, identification of the safety objectives by an application of the table of accident symptoms to the construction activities concerned (whether on going or planned in advance) seems an ideal procedure for planning an effective supervisory training programme.

In view of the rapidity of change of conditions on construction sites, the nature of the functions and goals of individuals also would be constantly changing. As a result new training needs are likely to appear from time to time. Therefore, a static list of objectives for each supervisory job is also unlikely to be adequate. A system of reviewing a job at any particular time for setting up a programme of adhoc objective setting and training also seems important. For this purpose, a job related approach to training is likely to be the most appropriate. In addition to any formal training programmes, there seems to be a vital need for an ongoing effort to monitor the workplace continually and introduce appropriate changes, which may involve supervisory training, training of personnel other than supervisors and/or non-training measures.

It is clear that here the term 'training' is not limited to mean merely formal training programmes. It has a broader meaning covering all activities which deliberately attempt to improve a person's performance in a job. It would be difficult to separate training from other management functions. Evaluation of supervisory safety training needs and the success of resultant training will clearly involve the total management. They also go well beyond the boundaries of safety and involve the sum total of all activities concerned in the construction process.

10.2 Summary and Conclusions

The nature of the field of study and the type of questions investigated made it necessary for this research to be carried out in a sequence of a number of different stages. In this process a gradual development of a method of investigation had to be simultaneously co-ordinated with the collection of necessary data. The detailed conclusions in relation to the different stages of the investigation are presented in the respective chapters of this thesis. The present section summarises the major conclusions pertaining to the aims of this research. They are presented under the following four headings.

I The method developed and tested for investigating the safety role of the first line construction supervisor with reference to his training needs.

II The factors influencing that role together with the relevant characteristics of the industry and its organisation.

III Safety role of the first line supervisor - the problems and the ways of coping with them.

IV Implications of the above for the scope of supervisory influence and training to improve site safety.

10.2.1 The Method

This research generated a method of wide-ranging use in identifying the factors which affect supervisory safety performance on a construction site. The method uses the perceptions and evaluations of the supervisor himself as its focus and consists of three basic parts.

(a) A table of accident symptoms to guide the field investigations of the site (Table 5 page 140).

(b) A flowchart consisting of a series of questions to be asked of the supervisor in sequence about the accident sumptoms present on the site (Page 128).

(c) A list of factors identified as likely influences giving rise to adverse safety performances, which provides guidance for probing questions at the interviews and for decisions concerning change programmes (Page 388).

The concept of accident symptoms and the list of those developed in the first part of the study were found to be meaningful and acceptable to supervisors as well as their superiors and safety officers for use as an instrument in identifying safety inadequacies in construction workplaces. The list of accident symptoms was developed from an analysis of a large sample of accident reports. The following are the headings developed as the main categories of accident symptoms. The symptoms were first separated into the four situational components - work setting, provision, personnel and system of work. Under each component were the following categories.

I Inadequacies of the resources and procedures used for the operations.

II Inadequacies of the diagnostic and/or hazard detection measures.

III Inadequacies of the preventive measures.

IV Inadequacies of the corrective and control measures.

V Inadequacies of the amiliorative and emergency measures.

VI Inadequacies of other relevant measures.

The flowchart developed in the study for use in the focussed interviews provided a successful way of highlighting the inadequacies and constraints which influenced the safety performance of a supervisor's section. As well as being acceptable and meaningful to supervisors, the flowchart also provided a means of analysing the data in a systematic manner to provide a clear indication of the factors influencing different stages of supervisory perception and evaluation of accident symptom occurrences. These stages refer to the following performance characteristics of a supervisor with respect to accident symptom occurrences in his section:

(a) recognition of his own
(b) acceptance when pointed out by someone else
(c) supervisor's acceptance of his own responsibility for action to deal with them
(d) acceptance of action by anybody to deal with them
(e) knowledge of a suitable method of dealing with them
(f) other reasons for the continued presence of the accident symptoms.

A total of 15 inter-related factors were derived from this part of the study as perceived by supervisors to influence their safety performance. They were as follows:

1 Adequacy of resources
2 Distribution and clarity of duties
3 Compatibility of demands
4 Degree of acceptance of hazards as inevitable
5 Influences of the social climate

6 Influences of traditional practice in the industry

7 Technical competence

8 Degree of dependence upon individual workpeople

9 Distribution and clarity of authority

10 The nature and extent of contingency situations

11 Safety management system factors

12 Degree of task overloading

13 Rules, policies and practices of the company

14 Effectiveness of information transfer

15 Understanding of legislation

Not all of these factors were found to influence all stages of the supervisor's perception and evaluation processes.
Recognition was influenced by factors 2, 3, 4, 6, 7, 8, 10, 11, 13, 14 and 15.
Acceptance when pointed out by someone else was influenced by factors 3, 4, 6, 8, 10 and 15.
Acceptance of supervisor's own responsibility for action was influenced by all the factors.
Acceptance of the need for anybody to take action was influenced by factors 3, 4, 6, 8, 10, 13 and 15.
Knowledge of a method of dealing with symptoms was influenced by factors 2, 7, 11 and 14.
Other reasons consisted of the factors 1, 3, 5, 10, 11, 12, and 13.

In a specific investigation a NO answer at any stage of the flowchart needs to be probed on all the possible influences relevant to that stage. In order to obtain complete information on the supervisory expectations with respect to the occurrence of a particular accident symptom it was found necessary to follow the full sequence of the flowchart. The tables of accident symptoms and influencing factors were also meaningful to the supervisors' superiors and the company safety officers, and were used in the final part of the study as a basis for checking the degree to which the supervisors' perceptions were congruent with those of the other role incumbents.

Statistical tests carried out to check whether there were significant differences in the factors influencing accident symptoms belonging to different situational components (work setting, provision, personnel and systems) showed that the method was robust against observer bias.

The data generated by the use of the method provide the essential basic information for decisions about supervisory training and other change programmes appropriate to a particular supervisor on a particular site. Such programmes must either change his perceptions, evaluations and/or capabilities to deal with accident symptoms, or change the situation around him to control the symptoms despite those perceptions, evaluations and/or capabilities. However, a clear and explicit organisational policy in relation to safety was found an essential pre-requisite to be used as a basis for the decisions about change programmes.

The method was demonstrated to meet satisfactorily the following three criteria, which were considered important for its success.

(a) It effectively highlighted safety problems present in an ongoing construction situation at any particular time, and also identified safety training objectives.

(b) It effectively highlighted a supervisor's perceptions with regard to the factors likely to influence his performance and behaviour relating to those problems.

(c) It generated information which was meaningful to managers and others concerned and which enabled them to diagnose the determinants underlying the supervisor's behaviour and thereby identify his training needs as well as his likely response to other changes.

10.2.2 Characteristics and Factors Influencing Safety Performance

The emergent nature of the construction process and transitional nature of construction sites, together with the need for methods, procedures and organisations in this industry to meet the demands of providing a unique structure on a unique location for the unique requirements of a client were found to give rise to special problems peculiar to this industry which affect safety on construction sites. These were discussed in detail in Chapters 2, 3 and 4 and summarised at the end of each chapter on pages 55, 80 and 105 respectively. The 15 factors identified in this study as inhibiting supervisory safety performance (see section 10.2.1 above) appear to be manifestations of these problems and the ways in which individual organisations and persons in this industry respond to them. These factors were discussed in detail in section 8.3.

A statistical analysis was carried out to test whether there was a significant variation between categories of different dimensions of supervisory background and site characteristics with respect to performance criteria and factors perceived to influence.

There seemed to be few, if any, important dimensions of supervisory background in which there were significant variations between categories so as to permit a prediction of the nature of problems and/or appropriate change programmes with respect to supervisors on the basis of their background.

However, a number of site variable dimensions appear to be important in connection with certain performance and influence variables (see section 8.5). These may be summarised as follows:

Supervisors in positions in which there is a greater need and opportunity to be well informed and knowledgeable about the work activities under their supervision seem significantly more likely to recognise accident symptom occurrences.

A higher degree of limitations in the extent of supervisory control and responsibility towards site activities and a greater tendency to employ specialist work groups seem to enhance the degree to which supervisors reject their own responsibility for action to deal with accident symptom occurrences.

Lump-sum contracts, larger size of the project and factors limiting the extent of the supervisor's overall control on site activities all seem to increase the degree of perception of the effects of lack of authority on safety performance.

Direct labour contracts, greater degree of completion of the project, smaller size of the project and limitations on the extent of supervisor's overall control of site activities, all appear to increase the degree of supervisory perception of the effects of social climate on safety performance.

It seems necessary to gain a thorough understanding of the variations through further studies designed to investigate specific variations on carefully selected samples, before any attempts to differentiate between the types of influences on different categories of any dimensions.

10.2.3 Safety Role - The Problems and Ways of Coping With Them

The supervisory safety role was investigated from the perspective of identifying safety training needs. Therefore the study was centred on the supervisor's own perceptions. Supervisors were found to experience a high degree of uncertainty concerning the nature and extent of their responsibility and authority with respect to safety functions. The high degree of lack of concurrence between the expectations of supervisors, their superiors and safety officers as regards supervisory safety functions, found in part 3 of the study, is prima facie evidence of the presence of organisational causes for the lack of clarity experienced by the supervisor. The uncertainty seemed mainly contributed to by the lack of implementation of a clear management policy concerning site safety, absence of an explicit definition of supervisory safety functions and the related authority pattern, and the need for a negotiated social order for the day to day progress of a variety of inter-related and changing operations amongst a number of varying groups of workpeople on the site. The safety role expectations as regards a particular supervisor were therefore largely dependent on contextual factors and were subject to a great deal of variation. They were also associated with the following three major problems.

(a) Supervisors experienced considerable difficulty in meeting both the technical and managerial demands of their safety role due to the lack of ability to cope with the range and complexity of the tasks required. However, there appeared to be a difference of opinion amongst different role incumbents of the organisation as to which of those tasks should be included amongst supervisory functions. The presence of one or more of the following factors seemed to cause and/or enhance this problem.

I Inadequacies in supervisory competence

II Lack of perceived authority

III Lack of information

IV Limitations of resources

V Inadequacies of safety management systems

VI Contingency situations

VII Unfavourable social climate

VIII Task overloading

In such cases supervisors were found to manage with a low level of safety on the site.

(b) Supervisors were found to experience a great deal of incompatibility between the expectations of the role of safety and that of their other work requirements, which needed separate and irreconcilable courses of action. There was evidence in the lack of agreement between the expectations of supervisors' superiors and of safety officers to suggest that these perceived incompatibilities could be real. The presence of one or more of the following factors was found to contribute to this problem.

I Safety demands incompatible with other performance criteria.

II The need to continue work progress with limited resources.

III A high incidence of contingency situations.

IV Company rules, policies and practices adverse to safety.

V Traditional practices, unfavourable to site safety.

As a result, supervisors were found to raise the threshold of conditions which they would categorise as accident symptoms and also to decide not to respond to some of the safety demands.

(c) Supervisors were also found to experience a considerable degree of conflict between their safety role expectations and their perception of the expectations and actions of other role incumbents of the organisation. The reality of this conflict too was supported by the expectations of supervisors' superiors and safety officers. This problem was found to be contributed to by the following factors.

I Social climate adverse to safety.

II Implementation of company rules, policies and practices which are unfavourable to site safety.

III Conflicting decisions on actions concerning incompatible demands.

IV Resistance by others to change traditional practices in favour of safety.

In a work climate in which there existed a high degree of pressure to maintain harmonious relations and interpersonnel agreement, this was found to have a marked influence upon supervisory performance. Supervisors were found to surrender their safety role expectations in many such cases.

As a means of coping with the above problems, supervisors were found to adopt a reactive approach, wherein they dealt mainly with the imminent and straightforward problems rather than following a careful and thorough-going effort to deal with all safety inadequacies. Limitations and boundaries were imposed to the expectations of their safety role in the following ways.

I They categorised some activities as outside the boundaries of supervisory duties.

II They surrendered a part of their authority.

III They accepted some hazards as inevitable.

IV They depended upon the individual workmen to cope with some hazards.

V They limited their safety effort to complying with legal requirements.

Some of the evidence seems to suggest that certain other role incumbents, particularly site agents may accept or even collaborate with the supervisors in the imposition of these limitations and boundaries.

10.2.4 Implications of the Above for Supervisory Influence and Training

The factors highlighted by supervisors as barriers in the work environment preventing the maintenance of an accident symptom free construction site indicate that their safety role is perceived as being subject to a wide range of influences external to themselves. A variety of characteristics of the nature of the industry and its organisation which contribute to these influences were also examined (see section 10.2.2). Supervisor's ability and effort alone seems inadequate and/or inappropriate to overcome a majority of the barriers against safety. Therefore, unless co-ordinated with the range of other organisational arrangements found important (see section 10. 1.3), the supervisor seems unlikely to be able to exercise a significant influence upon site safety.

Organisational arrangements for achieving site safety objectives were found to involve a combination in different degrees of a number of different activities and many compromises. In order to be effective, supervisory training would form only a part of a large programme which includes training of persons other than the supervisor and also a variety of actions other than training.

A clear and explicit safety policy for every site organisation to provide guidance for decisions concerning site safety seemed an essential pre-requisite to determining safety training needs of the supervisor. The table of accident symptoms (Table 5) is useful for determining the specific safety objectives of a site as well as for expressing the safety policy of the organisation in terms of contextual factors of the particular circumstances. The orgnaisational characteristics which must be taken into account are indicated by the 15 influencing factors (see section 10.2.1). Implications of these factors for training and other change programmes are discussed in section 10.1.3.

There was evidence to suggest that the specific safety objectives, the detailed safety policy, and the appropriate balance of different types of change programmes are all likely to be different for different supervisory jobs. Hence there seems to be a need for specific investigations and analyses of individual cases. Also, in view of the rapidly changing nature of each job, new training needs are likely to appear continuously, and as such, there also seems to be a need for continuous monitoring of each case. What is important therefore, is for the management to be capable of carrying out an analysis of the job as it exists at a particular time. This study provides a method consisting of the tools which can be conveniently administered for the purpose of this continuous analysis and indicates the possible key variables and decisions.

It is clear that safety training of the supervisor needs to be extended to cover a large variety of aspects of the organisation and be co-ordinated with a number of types of other change programmes (see section 10.1.3) in addition to improving his 'competence'. Also, it seems important that safety training be not limited to formal programmes, but should incorporate a variety of informal, on-the-job and adhoc activities. Successful safety training of the supervisor seems to involve the total management of the organisation and the whole of the construction process.

10.3 Implications for Further Research

The principal areas involved with the subject of this research, namely, construction supervision and construction safety, are both extremely complex. The lack of knowledge and understanding by way of research in these areas further contribute to the difficulties of setting up research studies into questions concerning them. There is a general need for more research to gain a clearer and more accurate understanding of both supervision and safety on construction sites. This section outlines some important indications arising out of this study for further research.

This study looked at the safety role of the construction supervisor using his own perceptions and evaluations. A number of factors were highlighted as influencing his safety role performance. These factors form a useful guide for further research on the subject.

Allocation of resources and effort for improvement of safety on a particular site, a firm or a group of firms need to be based upon a realistic set of priorities to ensure their optimum efficiency. Quantitative analysis is therefore necessary to evaluate these priorities. In such an investigation, the number or percentage of accident symptom occurrences to the presence of which a factor was found to contribute, can be used as a measure of its importance. The same measure also may be used to make a quantitative assessment of the influence of any one of the factors on the safety performance of a number of supervisors, sites or sections.

A clear indication emerging from this research is, that safety training of the supervisor may not be the best way of improving site safety in many construction workplaces. Even in the cases where it is likely to be significantly important, in order to optimise the effect of such training, a variety of other measures seem invariably essential. It is therefore crucial that expenditure of resources and effort on safety training of construction supervisors, whether on a national scale or in the case of a single company, be based on appropriate investigations.

In view of the incompatibilities perceived between various demands, and the conflict between expectations of other role incumbents of the organisation, perceived by supervisors, two types of investigation seem important. Firstly, studies to investigate the expectations of these other role incumbents with regard to the safety role of the supervisor seem useful to bring to light any discrepencies and disagreements. (Such studies would be extensions of the study in part 3 of this research which was carried out on a limited sample.)

Secondly, studies on the expectations of other role incumbents with respect to their own safety roles as well as expectations of supervisors with respect to the same safety roles would help divulge useful information regarding problems related to the inter-relationships between individuals.

The stategies adopted by different supervisors to deal with accident symptom occurrences provide another important approach to the study of the safety role of the construction supervisor. Such studies may be carried out in an experimental form in defined accident symptom situations using a number of supervisors.

There is much scope for research to investigate the relationships between different factors influencing safety performance in any particular organisation or group of orgnaisations. Relationships between the degree of influence of a particular factor and different characteristics of supervisors or organisations were investigated in the sample used in this research. Similar studies on specific factors in larger samples seem necessary for establishing more reliable relationships.

This study suggested that a detailed safety policy and a clear definition of safety functions would be important pre-requisites for decisions concerning change programmes. However, in view of the need for flexibility and lack of rigid control in construction organisations to meet the special demands of this industry, it seems important to investigate the degree to which policies and functions could be defined and implemented effectively.

This study highlighted a variety of problems concerning not only site organisations, but also the entire industry, which influence safety and supervision on sites. These problems imposed severe limitations upon the degree to which any improvement of safety could be achieved through efforts by individual organisations. There seems to be a great need for a reappraisal of the ways in which the entire construction industry should function in the light of the importance attached by the present day society to the improvement of safety of its industrial workforce.

APPENDIX 1

Classification of Accidents in Construction Processes

(Great Britain: Health and Safety Executive 1977)

Falls of persons (excluding falls from vehicles)
- From heights
- On the flat

Falls of materials
- From height
- On the flat

Excavations:
- Burial by fall of material
- Struck by material from the side (other than burial)

Tunnelling:
- Burial by fall of material
- Struck by material from side (other than burial)

Lifting equipment:
- Hoists (excluding falls of persons and materials):
  - Fall of platform or cage
  - Trapping by hoist
  - Other hoist accidents
- Cranes and lifting machines (including falls of persons and materials)

Machinery:
- Power and non-power machinery (other than lifting equipment)

Rail transport

Non-rail transport:
- Vehicle in motion not moved by power
- Vehicle moved by power
- Vehicle stationary

Electricity

Stepping on or striking against objects:
- Protruding nails
- Other objects

Hand tools (not power driven or cartridge operated)

Fires and explosion

continued

Poisoning and gassing

Handling goods (not elsewhere specified)

Other accidents

Further Classification of falls of persons or materials from heights

From scaffolds

From ladders or stepladders

Through openings in floors or walls, or from or down stairways

Through fragile roofing materials

From sloping roofs

Into excavations

From other working places, gangways or runs

Other falls from heights

APPENDIX 2

Detailed data on the field investigations in part 3 of the study are presented in this appendix. This data consist of the types of accident symptom occurrences on which each supervisor was interviewed, the supervisory responses at different stages of the interview flowchart, and whether the supvisory reasons were accepted or not by each of the supervisor's superiors and the safety officer. The numbers used to represent the accident symptom occurrences for presentation in the tables are the same as those in Chapter 9.

Supervisor Al

Supervisor Al was interviewed on the following 15 accident symptom occurrences found in his section.

1 Lack of stability

1a Lack of stability

2 Unsuitable construction

4 Improper stacking

5 Protruding objects

5a Protruding objects

10 Lack of fitness of equipment

11 Persons using inappropriate methods

11a Persons using inappropriate methods

12 Persons using unsound construction items

16 Location of hazard indicators less than adequate

18 System of mechanical handling unsuitable

22 System of hazard indicators less than adequate

23 Facilities provided for preventive measures less than adequate.

26 Systems adopted for control measures less than adequate.

TABLE 1 Supervisor A1 Failure to Recognise

Accident Symptom Occurrence	Supervisor's Reasons	Site Agent	Project Manager	Safety Officer
1	i Outside the boundaries of supervisory duties	Acc.	N.acc.	N.acc.
2	i Acceptance of hazard as inevitable	Acc.	N.acc.	N.acc.
	ii Tradition in the industry	N.acc.	N.acc.	N.acc.
	iii Dependence upon individual workmen	Acc.	Acc.	N.acc.
5	i Acceptance of hazard as inevitable	Acc.	N.acc.	N.acc.
	ii Dependence upon individual workmen	Acc.	Acc.	N.acc.
10	i Lack of information	Acc.	Acc.	N.acc.
11	i Outside the boundaries of supervisory duties	Acc.	Acc.	Acc.
	ii Dependence upon individual workmen	Acc.	Acc.	Acc.
18	i Outside the boundaries of supervisory duties	N.acc.	N.acc.	N.acc.
	ii Tradition in industry	Acc.	N.acc.	N.acc.
	iii Lack of technical competence	Acc.	N.acc.	N.acc.
22	i Outside the boundaries of supervisory duties	Acc.	Acc.	N.acc.
	ii Lack of technical competence	Acc.	Acc.	N.acc.
	iii Safety management systems inadequate	Acc.	Acc.	Acc.
23	i Tradition in industry	Acc.	Acc.	N.acc.
	ii Lack of technical competence	N.acc.	N.acc.	N.acc.
26	i Outside the boundaries of supervisory duties	Acc.	Acc.	N.acc.
	ii Lack of technical competence	Acc.	Acc.	N.acc.
	iii Safety management systems inadequate	Acc.	Acc.	Acc.

Acc. = Accepted

N.acc. = Did not accept

TABLE II Supervisor A1 Rejection of Supervisor's Own Action

Accident Symptom Occurrence	Supervisor's Reasons	Site Agent	Project Manager	Safety Officer
1	i Resource limitations	N.acc.	N.acc.	N.acc.
	ii Outside the boundaries of supervisory duties	N.acc.	N.acc.	N.acc.
	iii Tradition in industry	N.acc.	N.acc.	N.acc.
2	i Resource limitations	N.acc.	N.acc.	N.acc.
	ii Acceptance of hazards as inevitable	Acc.	N.acc.	N.acc.
	iii Dependence upon individual workmen	Acc.	Acc.	Acc.
4	i Resource limitations	Acc.	Acc.	N.acc.
	ii Incompatible demands	Acc.	N.acc.	N.acc.
5	i Incompatible deamnds	Acc.	N.acc.	N.acc.
	ii Acceptance of hazards as inevitable	Acc.	Acc.	N.acc.
	iii Dependence upon individual workmen	Acc.	Acc.	N.acc.
	iv Not covered by legislation	Acc.	N.acc.	N.acc.
10	i Outside the boundaries of supervisory duties	N.acc.	Acc.	Acc.
11	i Outside the boundaries of supervisory duties	Acc.	N.acc.	N.acc.
	ii Acceptance of hazards as inevitable	Acc.	Acc.	N.acc.
	iii Dependence upon individual workmen	Acc.	Acc.	Acc.
	iv Tradition in industry	Acc.	N.acc.	N.acc.
16	i Resource limitations	Acc.	Acc.	N.acc.
	ii Outside supervisory duties	N.acc.	Acc.	N.acc.
	iii Incompatible demands	Acc.	Acc.	N.acc.
18	i Outside the boundaries of supervisory duties	Acc.	Acc.	N.acc.
	ii Tradition in industry	Acc.	Acc.	N.acc.
	iii Lack of technical competence	N.acc.	Acc.	Acc.
	iv Dependence upon individual workmen	Acc.	N.acc.	N.acc.

TABLE II continued

Accident Symptom Occurrence	Supervisor's Reasons	Site Agent	Project Manager	Safety Officer
22	i Outside the boundaries of supervisory duties	Acc.	Acc.	N.acc.
	ii Lack of technical competence	Acc.	N.acc.	N.acc.
	iii Safety management system inadequacies	Acc.	Acc.	Acc.
	iv Company policy	N.acc.	N.acc.	N.acc.
23	i Incompatible demands	Acc.	Acc.	N.acc.
	ii Lack of technical competence	Acc.	N.acc.	N.acc.
	iii Tradition in industry	Acc.	Acc.	N.acc.
26	i Outside the boundaries of supervisory duties	Acc.	Acc.	Acc.
	ii Lack of technical competence	Acc.	N.acc.	Acc.
	iii Safety management system inadequacies	Acc.	Acc.	Acc.
	iv Company policy	N.acc.	N.acc.	N.acc.

Acc. = Accepted

N.acc. = Did not accept

TABLE III Supervisor A1 Rejection of Action by Anybody

Accident Symptom Occurrence		Supervisor's Reasons	Site Agent	Project Manager	Safety Officer
2	i	Acceptance of hazards as inevitable	Acc.	N.acc.	N.acc.
	ii	Dependence upon individual workmen	Acc.	Acc.	N.acc.
5	i	Acceptance of hazards as inevitable	Acc.	Acc.	N.acc.
	ii	Dependence upon individual workmen	Acc.	Acc.	N.acc.
11	i	Acceptance of hazards as inevitable	Acc.	Acc.	N.acc.
	ii	Dependence upon individual workmen	Acc.	Acc.	N.acc.
18	i	Tradition in industry	Acc.	Acc.	N.acc.
	ii	Dependence upon individual workmen	Acc.	N.acc.	N.acc.
23	i	Tradition in industry	Acc.	Acc.	N.acc.

Acc. = Accepted

N.acc. = Did not accept

TABLE IV Supervisor A1 Lack of Knowledge of a Suitable Method

Accident Symptom Occurrence	Supervisor's Reasons	Site Agent	Project Manager	Safety Officer
2	i Outside the boundaries of supervisory duties	N.acc.	N.acc.	N.acc.
11	i Outside the boundaries of supervisory duties	Acc.	N.acc.	N.acc.
18	i Outside the boundaries of supervisory duties	Acc.	Acc.	N.acc.
	ii Lack of technical competence	N.Acc.	N.acc.	N.acc.
22	i Outside supervisory duties	Acc.	Acc.	Acc.
	ii Lack of technical competence	Acc.	Acc.	Acc.
	iv Safety management system inadequacies	Acc.	Acc.	Acc.
	v Lack of information	Acc.	Acc.	Acc.
23	i Lack of technical competence	Acc.	Acc.	N.acc.
	ii Lack of information	Acc.	Acc.	Acc.
26	i Outside supervisory duties	Acc.	Acc.	Acc.
	ii Lack of technical competence	Acc.	Acc.	Acc.
	iii Safety management system inadequacies	Acc.	Acc.	Acc.
	iv Lack of information	Acc.	Acc.	Acc.

Acc. = Accepted

N.acc. = Did not accept

TABLE V Supervisor A1 Other Reasons for the Presence of Accident Symptom Occurrence

Accident Symptom Occurrence	Supervisor's Reasons	Site Agent	Project Manager	Safety Officer
1a	i Contingency situation	Acc.	Acc.	N.acc.
	ii Task overloading	Acc.	Acc.	N.acc.
5a	i Resource limitations	Acc.	Acc.	N.acc.
	ii Incompatible demands	Acc.	Acc.	N.acc.
11a	i Influences of the social climate	Acc.	N.acc.	N.acc.
12	i Contingency situation	Acc.	Acc.	N.acc.
	ii Incompatible demands	Acc.	Acc.	N.acc.
	iii Task overloading	Acc.	Acc.	N.acc.

Acc. = Accepted

N.acc. = Did not accept

Supervisor A2

Supervisor A2 was interviewed in the following 11 types of accident symptom occurrences found in his section.

1b Lack of stability

6 Accessible edges

6a Accessible edges

7 Obstructions

7a Obstructions

7b Obstructions

8 Harmful construction material

13 Inappropriate layout

14 Persons failing to adopt control measures

19 System of operation unsuitable

21 System of diagnosing and monitoring hazards less than adequate

TABLE VI Supervisor A2 Failure to Recognise

Accident Symptom Occurrence	Supervisor's Reasons	Site Agent	Project Manager	Safety Officer
6	i Acceptance of hazards as inevitable	N.acc.	N.acc.	N.acc.
	ii Dependence upon individual workmen	N.acc.	N.acc.	N.acc.
7	i Acceptance of hazards as inevitable	Acc.	Acc.	N.acc.
	ii Dependence upon individual workmen	Acc.	Acc.	N.acc.
	iii Lack of legislation	Acc.	N.acc.	N.acc.
7b	i Outside supervisory duties	N.acc.	Acc.	Acc.
	ii Dependence upon individual workmen	Acc.	Acc.	N.acc.
8	i Contingency situation	Acc.	N.acc.	N.acc.
	ii Safety management system inadequacies	Acc.	N.acc.	Acc.
	iii Lack of information	N.acc.	N.acc.	N.acc.
13	i Outside supervisory duties	N.acc.	Acc.	Acc.
	ii Contingency situation	Acc.	N.acc.	N.acc.
	iii Company practices	N.acc.	N.acc.	N.acc.
21	i Safety management system inadequacies	Acc.	Acc.	Acc.
	ii Lack of technical competence	N.acc.	N.acc.	N.acc.
	iii Company practices	N.acc.	N.acc.	N.acc.

Acc. = Accepted

N.acc. = Did not accept

TABLE VII Supervisor A2 Rejection of Supervisor's Own Action

Accident Symptom Occurrence	Supervisor's Reasons	Site Agent	Project Manager	Safety Officer
1b	i Resource limitations	Acc.	N.acc.	N.acc.
	ii Incompatible demands	Acc.	N.acc.	N.acc.
	iii Contingency demands	Acc.	Acc.	N.acc.
6	i Acceptance of hazards as inevitable	N.acc.	N.acc.	N.acc.
	ii Dependence upon individual workmen	N.acc.	N.acc.	N.acc.
	iii Influences of the social climate	Acc.	N.acc.	N.acc.
6a	i Resource limitations	Acc.	Acc.	N.acc.
	ii Contingency situation	Acc.	Acc.	N.acc.
	iii Dependence upon individual workmen	N.acc.	N.acc.	N.acc.
7	i Acceptance of hazards as inevitable	Acc.	Acc.	N.acc.
	ii Dependence upon individual workmen	Acc.	Acc.	N.acc.
	iii Lack of legislation	Acc.	N.acc.	N.acc.
7b	i Outside supervisory duties	Acc.	N.acc.	N.acc.
	ii Dependence upon individual workmen	Acc.	Acc.	N.acc.
13	i Outside supervisory duties	N.acc.	Acc.	N.acc.
	ii Contingency situations	Acc.	N.acc.	N.acc.
	iii Company practice	N.acc.	N.acc.	N.acc.
21	i Safety management system inadequacies	Acc.	Acc.	Acc.
	ii Lack of technical competence	N.acc.	N.acc.	N.acc.
	iii Company practice	N.acc.	N.acc.	N.acc.

Acc. = Accepted

N.acc. = Did not accept

TABLE VIII Supervisor A2 Rejection of Action by Anybody

Accident Symptom Occurrence	Supervisor's Reasons	Site Agent	Project Manager	Safety Officer
7	i Acceptance of hazards as inevitable	Acc.	Acc.	N.acc.
	ii Dependence upon individual workmen	Acc.	Acc.	N.acc.
	iii Lack of legislation	Acc.	N.acc.	N.acc.

TABLE IX Supervisor A2 Lack of Knowledge of a Suitable Method

Accident Symptom Occurrence	Supervisor's Reasons	Site Agent	Project Manager	Safety Officer
8	i Safety management system inadequacies	Acc.	N.acc.	Acc.
	ii Lack of information	N.acc.	N.acc.	N.acc.
13	i Outside supervisory duties	N.acc.	Acc.	Acc.
	ii Company practice	N.acc.	N.acc.	N.acc.
21	i Safety management system inadequacies	Acc.	Acc.	Acc.
	ii Lack of technical competence	N.acc.	N.acc.	N.acc.
	iii Company practice	N.acc.	N.acc.	N.acc.

TABLE X Supervisor A2 Other Reasons

Accident Symptom Occurrence	Supervisor's Reasons	Site Agent	Project Manager	Safety Officer
7a	i Contingency situation	Acc.	N.acc.	N.acc.
	ii Task overloading	Acc.	N.acc.	N.acc.
14	i Influences of social climate	Acc.	Acc.	N.acc.
19	i Contingency situation	Acc.	N.acc.	N.acc.

Acc. = Accepted

N.acc. = Did not accept

Supervisor B

Supervisor B was in charge of the site himself. Therefore there was no site agent as his superior. He was interviewed on the following 10 types of accident symptom occurrences found in his site.

2a Unsuitable construction

4a Improper stacking

7c Obstruction

12a Persons using unsound construction items

15 Persons assigned to the function of diagnosing hazards less than competent

16a Location of hazard indicators less than adequate

17 System of transport unsuitable

22a System of hazard indication less than adequate

25 Construction of corrective measures less than adequate

25a Construction of corrective measures less than adequate

TABLE XI Supervisor B Failure to Recognise

Accident Symptom Occurrence	Supervisor's Reasons	Project Manager	Safety Officer
12a	i Outside supervisory duties	Acc.	N.acc.
	ii Dependence upon individual workmen	N.acc.	N.acc.
15	i Lack of technical competence	N.acc.	N.acc.
	ii Lack of information	N.acc.	N.acc.
22a	i Contingency situations	Acc.	N.acc.

Acc. = Accepted

N.acc. = Did not accept

TABLE XII Supervisor B Rejection of Supervisor's Own Action

Accident Symptom Occurrence	Supervisor's Reasons	Project Manager	Safety Officer
2a	i Outside supervisory duties	Acc.	N.acc.
	ii Dependence upon individual workmen	Acc.	N.acc.
	iii Task overloading	Acc.	N.acc.
12a	i Outside supervisory duties	Acc.	N.acc.
	ii Dependence upon individual workmen	N.acc.	N.acc.
17	i Resource limitations	Acc.	Acc.
	ii Incompatible demands	Acc.	Acc.
	iii Dependence upon individual workmen	Acc.	N.acc.
25	i Resource limitations	N.acc.	N.acc.
25a	i Resource limitations	N.acc.	N.acc.

Acc. = Accepted

N.acc. = Did not accept

Supervisor B did not reject any of the accident symptom occurrences from action by anybody.

TABLE XIII Supervisor B Lack of Knowledge of a Suitable Method

Accident Symptom Occurrence	Supervisor's Reasons	Project Manager	Safety Officer
15	i Lack of technical competence	N.acc.	N.acc.
	ii Lack of information	N.acc.	N.acc.

TABLE XIV Supervisor B Other Reasons

Accident Symptom Occurrence	Supervisor's Reasons	Project Manager	Safety Officer
4a	i Resource limitations	Acc.	Acc.
	ii Contingency situations	Acc.	N.acc.
	iii Incompatible demands	Acc.	Acc.
7c	i Resource limitations	N.acc.	N.acc.
	ii Task overloading	N.acc.	N.acc.
16a	i Contingency situation	N.acc.	N.acc.
22a	i Contingency situation	N.acc.	N.acc.
25a	i Safety management system inadequacies	Acc.	Acc.

Acc. = Accepted

N.acc. = Did not accept

Supervisor C

Supervisor C was interviewed on the following 13 types of accident symptom occurrences found in his section.

1 Lack of stability

3 Unsuitable loading

3a Unsuitable loading

5b Protruding objects

5c Protruding objects

6b Accessible edges

7d Obstructions

9 Falling objects

10a Lack of fitness of construction equipment

14a Persons failing to adopt control measures

20 System of manual handling unsutiable

24 System of adopting preventive measures less than adequate

26 Systems adopted for control measures less than adequate

TABLE XV Supervisor C Failure to Recognise

Accident Symptom Occurrence	Supervisor's Reasons	Site Agent	Project Manager	Safety Officer
1c	i Contingency situation	N.acc.	N.acc.	N.acc.
	ii Incompatible demands	N.acc.	N.acc.	N.acc.
3	i Outside supervisory duties	Acc.	Acc.	N.acc.
	ii Tradition in industry	Acc.	Acc.	N.acc.
	iii Lack of legislation	N.acc.	N.acc.	N.acc.
5b	i Acceptance of hazards as inevitable	N.acc.	N.acc.	N.acc.
	ii Dependence upon individual workmen	Acc.	Acc.	N.acc.
5c	i Outside supervisory duties	Acc.	Acc.	Acc.
10a	i Outside supervisory duties	Acc.	Acc.	Acc.
	ii Safety management system inadequacies	Acc.	Acc.	Acc.
20	i Dependence upon individual workmen	Acc.	Acc.	N.acc.
24	i Lack of technical competence	N.acc.	N.acc.	N.acc.
	ii Safety management system inadequacies	Acc.	Acc.	Acc.
26a	i Safety management system inadequacies	N.acc.	N.acc.	N.acc.

Acc. = Accepted

N.acc. = Did not accept

TABLE XVI Supervisor C Rejection of Supervisor's Own Action

Accident Symptom Occurrence	Supervisor's Reasons	Site Agent	Project Manager	Safety Officer
3	i Outside supervisory duties	Acc.	Acc.	N.acc.
	ii Lack of legislation	N.acc.	N.acc.	N.acc.
	iii Lack of authority	Acc.	N.acc.	N.acc.
3a	i Influence of social climate	N.acc.	N.acc.	N.acc.
5b	i Acceptance of hazards as inevitable	N.acc.	N.acc.	N.acc.
	ii Dependence upon individual workmen	Acc.	Acc.	N.acc.
5c	i Outside supervisory duties	Acc.	Acc.	Acc.
	ii Lack of authority	Acc.	Acc.	Acc.
7d	i Resource limitations	Acc.	N.acc.	N.acc.
	ii Incompatible demands	Acc.	N.acc.	N.acc.
10a	i Outside supervisory duties	Acc.	Acc.	Acc.
	ii Safety management system inadequacies	Acc.	Acc.	Acc.
20	i Dependence upon individual workmen	Acc.	Acc.	N.acc.
24	i Lack of technical competence	N.acc.	N.acc.	N.acc.
	ii Safety management system inadequacies	Acc.	Acc.	Acc.
26a	i Outside supervisory duties	N.acc.	N.acc.	N.acc.
	ii Safety management system inadequacies	N.acc.	N.acc.	N.acc.

Acc. = Accepted

N.acc. = Did not accept

TABLE XVII Supervisor C Rejection of Action by Anybody

Accident Symptom Occurrence	Supervisor's Reasons	Site Agent	Project Manager	Safety Officer
5b	i Acceptance of hazards as inevitable	N.acc.	N.acc.	N.acc.
	ii Dependence upon individual workmen	Acc.	Acc.	N.acc.
20	i Dependence upon individual workmen	Acc.	Acc.	N.acc.

TABLE XVIII Supervisor C Lack of Knowledge of a Suitable Method

Accident Symptom Occurrence	Supervisor's Reasons	Site Agent	Project Manager	Safety Officer
5c	i Outside supervisory duties	Acc.	Acc.	Acc.
	ii Lack of technical competence	N.acc.	N.acc.	N.acc.
10a	i Outside supervisory duties	Acc.	Acc.	Acc.
	ii Safety management system inadequacies	Acc.	Acc.	Acc.
24	i Lack of technical competence	N.acc.	N.acc.	N.acc.
	ii Safety management system inadequacies	Acc.	Acc.	Acc.
26a	i Outside supervisory duties	N.acc.	N.acc.	N.acc.
	ii Lack of technical competence	N.acc.	N.acc.	N.acc.
	iii Safety management system inadequacies	N.acc.	N.acc.	N.acc.

Acc. = Accepted

N.acc. = Did not accept

TABLE XIX Supervisor C Other Reasons

Accident Symptom Occurrence	Supervisor's Reasons	Site Agent	Project Manager	Safety Officer
1c	i Resource limitations	Acc.	N.acc.	N.acc.
6b	i Task overloading	N.acc.	N.acc.	N.acc.
9	i Resource limitations	Acc.	N.acc.	N.acc.
	ii Contingency situation	N.acc.	N.acc.	N.acc.
14a	i Influences of the social climate	Acc.	N.acc.	N.acc.

Acc. = Accepted

N.acc. = Did not accept

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