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Safety Culture During Major Organisational Change

BRYAN O'LOUGHLIN

Doctor of Philosophy

THE UNIVERSITY OF ASTON IN BIRMINGHAM

April 1998

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Summary

This research examines the effect of major changes, in the external context, on the safety culture of a UK generating company. It was focused on an organisation which was originally part of the state owned Central Electricity Generating Board and which, by the end of the research period, was a self-contained generating company, operating in a competitive market and a wholly owned subsidiary of a US utility. The research represents an attempt to identify the nature and culture of the original organisation and to identify, analyse and explain the effects of the forces of change in moulding the final organisation. The research framework employed a qualitative methodology to investigate the effects of change, supported by a safety culture questionnaire, based on factors identified in the third report of the ACSNI Human Factors Study Group; Organising for Safety, as being indicators of safety culture. An additional research objective was to assess the usefulness of the ACSNI factors as indicators of safety culture. Findings were that the original organisation was an engineering dominated technocracy with a technocentric safety culture. Values and beliefs were very strongly held and resistant to change and much of the original safety culture survived unchanged into the new organisation. The effects of very long periods of uncertainty about the future were damaging to management/worker relationships but several factors were identified which effectively insulated the organisation from many of the effects of change. The forces of change had introduced a beneficial appreciation of the crucial relationship between safety risk assessment and commercial risk assessment. Although the technical strengths of the original safety culture survived, so did the essential weakness of a low level of appreciation of the human behavioural aspects of safety. This led to a limited, functionalist world view of safety culture, which assumed that cultural change was simpler to achieve than was the case and an inability to make progress in certain areas which were essentially behavioural problems. The factors identified by ACSNI provided a useful basis for the site research methodology and for identifying areas of relative strength and weakness in the site safety arrangements.

KEY WORDS: Safety Culture, Organisational Change, Safety Management, Electricity Supply Industry

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¹ Diagrams in Figures 2, 3, and 12 taken from PSB publicity brochures. Diagram in Figure 13 taken from Bedding D, (1994), Assessment of Proposed Procedure to Replace Main Inlet Valve.

Glossary

BST	Bulk Supply Tariff
CEGB	Central Electricity Generating Board
CHIRP	Confidential Hazard Incident Reporting Procedure
CW	Cooling Water
DTV	Draft Tube Valve
ENERGIS	Wholly owned telecommunication subsidiary of NGC
EPFAL	Energy Pool Funds Administration Ltd
ESI	Electricity Supply Industry
FE	Frequency of Exposure
FEA	Finite Element Analysis
FH	First Hydro
GENCO	Generating Company
GM	General Manager
HESAC	Health and Safety Advisory Committee
HP	High Pressure
HRN	Hazard Rating Number
LOLP	Loss of Load Probability
MIV	Main Inlet Valve
MPL	Maximum Probable Loss
NGC	National Grid Company plc
NGG	National Grid Group
NGH	National Grid Holding Company
OFFER	Office for Electricity Regulation
PE	Probability of Exposure
PNB	Power Network Business
POOL	The organisation established to operate a spot market for electricity
PPP	Pool Purchase Price
PSB	Pumped Storage Business
PSD	Power Services Division
PSP	Pool Selling Price
QA	Quality Assurance
REC	Regional Electricity Company
ROV	Remotely Operated Vehicle
RPI	Retail Price Index
SLA	Service Level Agreement
SMP	System Marginal Price
SPE	Shift Production Engineer
STARS	Staff Target And Review Scheme
VLL	Value of Load Lost

Chapter 1

OVERVIEW OF THESIS

*Errors, like straws, upon the surface flow;
He who would search for pearls must dive below.²*

John Dryden 1631-1700

1.1 Introduction

This Chapter provides an overview of this thesis. It will elaborate on the research objectives and the purpose of the research and the research methodology, will be explained. The justification for the work will be given and the structure of the thesis will be set out.

1.2 Research Question

The research aims to identify, analyse and explain the effect of major change on the safety culture of a Pumped Storage Business (PSB), within the UK electricity supply industry. Detailed data collection was carried out between 1994 and 1997 although the change process had begun in 1989. The research aims to examine the nature and culture of the original organisation from which the business evolved and to track the influences of the forces and events which may have moulded its culture. The research was to evaluate specifically the factors identified in the third report of the ACSNI Human Factors Study Group, Organising for Safety (HSC 1993), as being indicators of safety culture.

1.3 Research Objectives

The objectives of this research are:

1. To examine and analyse the nature and culture of the environment and organisation from which PSB evolved.
2. To identify and analyse the influences and events impacting on the safety culture of PSB during a period of major change.

² Chapter quotations are, in general, taken from The Penguin Dictionary of Quotations, 1971.

3. To identify and analyse the detrimental or beneficial effects of the changes on the safety culture of PSB.
4. To consider specifically, the cultural indicators identified in the third ACSNI report.
5. To develop and test the usefulness of a safety culture questionnaire based on the ACSNI indicators.
6. To provide a detailed review of the relevant literature.

1.4 A Note About The Author

The author of this thesis has spent a career in various parts of the UK electricity supply industry, both as an operational engineer and from 1972 to 1994 as a safety professional. The period from 1989 until 1994 was spent as safety advisor to the National Grid Company. The author was therefore an active participant in much of the process being described and a party to some of the debates. This fact may threaten the detachment expected in academic research, although every effort has been made to remain objective. However, it also means that the author has knowledge of many aspects of the process beyond those available to an entirely detached observer. The author is also aware of the danger that the cultural perspective of subjective judgement could be that of an engineer and manager. However, the role of the safety professional affords the privilege of regular contact with all levels and types of staff and an essential part of the role is to identify with their various situations. It is believed by the author, that this perspective has provided a unique insight which assists in maintaining objectivity.

1.5 Justifications for the Research

There are three main justifications for this research. The first justification arises from the importance of safety culture and the increasing pace of organisational change. The importance of safety culture has been dramatically demonstrated in a succession of high profile accidents including Chernobyl, The Herald of Free Enterprise, the King's Cross fire, the Clapham accident and the Challenger disaster. Many researchers have analysed safety culture and identified the factors which are believed to be indicators of a good safety culture. The recent decade has seen considerable organisational changes, particularly in the former state owned utilities, which have very largely been privatised, sold to new owners and broken up into separate companies. Such companies now have new priorities and many have experienced internal organisational changes including

downsizing, outsourcing and the creation of internal markets. In view of the undoubted significance of safety culture and the ever present nature of organisational change, it would seem reasonable to suggest that a better understanding of the effects of change on safety culture would be desirable if only to avoid unnecessary detrimental effects on safety culture during the change process and perhaps to suggest ways in which change can strengthen safety culture.

Research into safety culture is likely to be intrusive for any organisation which is the subject of a study. Interviewing managers and staff is demanding of their time and of company resources. Observing work activity can only be done after careful preparation and confidence building. Questionnaires may impact on the company's own programme of communicating with its employees. For all these reasons a programme of research into safety culture, requires an understanding and co-operative subject. The second justification for this research is that the researcher had good links with the subject organisation and that they were willing participants.

The third justification arises from the fact that the researcher had detailed knowledge of the industry and had information about the evolutionary process being studied, which provided insights that would not otherwise be available. This knowledge came from a long involvement with the industry and it was necessary to ensure that the objectivity of the research was adequately protected. (See 1.4 above.)

1.6 Research Methodology

The research may be subdivided into three broad aspects:

1. An historical review and analysis to establish the nature and culture of the industry and the original organisation which was to be subjected to change in its external context.
2. Direct observation on site, examination and analysis of procedures and structured interviews and informal discussions.
3. The development and use of a safety culture questionnaire to obtain additional data to support or contradict the views formed from direct observation and discussion and to allow further analysis.

1.6.1 Historical Review

The first aspect of the research was an historical review and retrospective analysis of the nature and the culture of the industry and organisation from which PSB was to evolve. The objective was to gain an appreciation of the values, beliefs and attitudes which characterised the original organisation and which formed the cultural inheritance of PSB. The author has drawn upon his knowledge and experience as a manager in the industry, to trace the evolution of the culture in PSB from its CEGB inheritance. The research covering the period up to 1989 was done using referenced sources insofar as they were available to the author but also using the author's personal knowledge as an observer of the events. This same process was utilised to analyse the events from 1989 to the start of data collection in PSB in 1994.

1.6.2 Direct Data Collection on Site

Collection of data on site was preceded by meetings with managers to indicate the nature of the process, the access and facilities required and to obtain their agreement to the research programme. This was followed by meetings with staff representatives to ensure that they understood the nature and purpose of the study, to allay any fears, to assure them of the independence of the researcher from PSB management, to provide assurances of anonymity and to enlist their co-operation. Presentations were then given to staff consultative bodies and to individual groups of staff, to explain the research, to give reassurances and obtain co-operation.

The research data was initially based on a combination of informal discussions with managers and staff, structured interviews with a representative selection of individuals and direct observation of activities, examination of procedures and site inspections. A condition of the research was that all information was given in confidence and respondents and interviewees were to remain anonymous. This has been respected and the quotations in this thesis must therefore remain non-attributable. Statements in quotation remarks represent verbatim statements made during discussions and interviews.

1.6.3 The Development and Use of the Safety Culture Questionnaire

A safety culture questionnaire was then developed which could be used to obtain views from a much larger sample of staff than it was possible to interview. The questionnaire

responses could be used to test the accuracy of judgements and impressions based on the more subjective direct observations. Additionally the questionnaire data would allow further analysis and it could also be used after a time interval as the basis of a longitudinal study. It was further intended that the questionnaire could be used to evaluate the usefulness of the ACSNI prompt-list.

The questionnaire was drawn up and was validated with staff representatives before being issued to all staff. The responses were then analysed. The questionnaire was issued for the second time some two years later, in 1997. Site data collection continued, in order to track the changes and events in the intervening period.

1.7 Field Research Challenges

The total population on which the research was conducted was less than 200 individuals. This presented a particular challenge for the statistical analysis of the results. The response rate to the first issue of the questionnaire was quite good although the total number of respondents was such as to make some of the statistical analysis marginal. The response rate to the second issue was significantly lower and the total number of responses made certain statistical analyses untenable.

It is acknowledged that during the time spent on site, gathering data, the very presence of the author influenced the course of events to some degree. For example, questioning staff about risk assessment certainly had the effect of creating an awareness of a subject about which there was little if any, awareness at the start of the research. Very specifically, the management asked, at the outset, for a report of initial findings, conclusions and suggestions and committed themselves to making this report available to all staff. A report was prepared and forms Appendix C to this thesis. The report was accepted and naturally had a direct influence on the situation, although the way in which it was received was also very revealing in terms of safety culture.

1.8 Chapter Contents

Chapter titles and the topics covered within each Chapter are listed in the Table 1.1 on the following page.

Table 1.1

CHAPTER	TITLE	CONTENT
One	Overview of Thesis	Introduction and overview of the research.
Two	Literature Review	Literature review relating to safety culture, accident causation, organisational structures, organisational culture, the changing of culture and measurement of culture.
Three	Organisational Overview	A brief overview of the ESI and the Pumped Storage Business within that context.
Four	The Evolution of PSB	PSB within the NGC context, the business of PSB and its organisational structure.
Five	Pre-1989; The Cultural Inheritance	The CEGB, its environment, its culture and safety culture.
Six	Post-1989; The Changed Environment	Privatisation, changes in the environment, the organisation and culture of NGC, changes in NGC.
Seven	Evaluation of the PSB Safety Culture Part 1 – Methodology, Policy, Procedures	Methodology of site work and consideration of policy and procedures.
Eight	Evaluation of the PSB Safety Culture Part 2 – Site Observations	Data from discussions, interviews and site observations.
Nine	Evaluation of the PSB Safety Culture Part 3 – Development and Use of the Safety Culture Questionnaire	Development of safety culture questionnaire, first issue, analysis, second issue, analysis.
Ten	Collation and Presentation of Site Data	Data derived from all site research
Eleven	Events in First Hydro from March 1995 to February 1997	Organisational change, cultural issues
Twelve	Discussion and Conclusions	Discussion of research results. conclusions

Chapters 3 to 6, comprise an account of the first phase of the research, the historical review and analysis. These chapters establish the nature of the industry and organisation from which PSB evolved and the values, attitudes and beliefs which formed the cultural inheritance of PSB. Chapter 6 also describes the changes in the external context of NGC and the response of NGC to these changes and the changing forces acting upon PSB.

The second phase of the research, the site work, may be divided into three separate stages, examination of policy and procedures, site observations and the use of the questionnaire. In fact this division, although convenient, is somewhat artificial. Each stage informs the others and in practice they overlapped in time. The Chapters are therefore arranged for convenience and simplicity rather than implying a chronological sequence.

Chapters 7 and 8 describe the second phase of the research, direct data collection on site, involving the study and analysis of procedures, informal discussions, structured interviews and direct observation. The overall methodology for the site work is discussed in Chapter 7.

Chapter 9 describes the third phase of the research, the development and use of the safety culture questionnaire and goes on to combine an analysis of the responses from the questionnaire and the data derived from direct observation. The site data is presented in Chapter 10 as found, without analysis.

Chapter 11 provides an account of developments in PSB between the first and second issues of the questionnaire and Chapter 12 comprises discussion, analysis and conclusions from all of the research.

Chapter 2

Literature Review

Everything of importance has been said before by someone who did not discover it.

Alfred North Whitehead 1861-1947

2.1 Overview

This thesis explores the influence of environment on safety culture by observing an organisation during a period of considerable change in the external, political and commercial environment. The effect (or lack of effect), of these changes on different levels of the organisation, is recorded. Of particular interest are the direct and indirect effects of the changed environment on the culture of the organisation and specifically on the safety culture. It is assumed that “a good safety culture” is a desirable objective and therefore that a better appreciation of how this may be developed, fostered and maintained, is a matter of some importance. Proactive management of safety can only be aided by a better understanding of the factors which may exert a negative or positive influence on safety culture.

This review of the literature therefore embraces the concepts of safety culture and organisational culture, as well as the relationship between the environment and organisational behaviour. The review begins with a consideration of organisational safety culture and then explores in more detail, the work done into some of those aspects that are held to be important in relation to the concept of safety culture. The review then considers organisational culture in a wider context and some aspects of organisational theory, before concluding with references to the factors influencing cultural change and to work relating to the measurement of safety culture.

2.2 Safety Climate

The origins of the concept of safety culture lie in the work of Zohar, (1980), who used the term safety climate to describe attitudes towards safety. Safety climate is concerned with the shared perceptions and beliefs that workers hold about safety. A good safety climate is characterised by a collective commitment of care and concern which, when

combined with good technical, ergonomic and organisational practices, can create a perceived image of risk, danger and safety, which is self-sustaining. Zohar developed a 20 point measurement scale which he applied in industrial contexts in Israel. He used a questionnaire to correlate employees' perceptions of the relative importance of safe conduct within their occupations, with the effectiveness of safety programmes. Zohar's model comprised eight dimensions:

- *The importance of safety training programmes*
- *Management attitudes towards safety*
- *The effects of safe conduct on promotion*
- *The level of risk at the workplace*
- *The effects of the required work pace on safety*
- *The status of the safety officer*
- *The effects of safe conduct on social status*
- *The status of the safety committee*

These factors were later reduced to three by Brown and Holmes, (1986), working with US production workers:

- *Employee perception of management concern at their well-being*
- *Employee perception of how well management is responding to this concern*
- *Employee perception of physical risks*

Studies by Dedobbeleer and Beland, (1991) at nine US construction sites, supported the Brown and Holmes model but found the best fit for their data with a two factor model, comprising:

- *Management's commitment to safety in terms of management's safety attitudes and practices*
- *Workers' involvement in safety, (which appeared to subsume workers' perception of risk)*

Cooper and Phillips, (1994) found that two factors best fit their data, which was based on a study involving UK production workers. The factors were:

- *Direct factors which affect perceptions of safety climate, including risk level, managerial attitudes, work pace, management actions and safety training*

- *Indirect factors including safety training, effects of working safely on social status and promotion and the effectiveness of safety advisors and safety committees*

It may be seen from the above that the various studies have produced a reasonably consistent view of what constitutes safety climate. All the findings demonstrate, explicitly or implicitly, the importance of factors such as management attitude and commitment, care and concern, training, involvement and perception of risk.

2.3 Safety Culture

The related concept of safety culture was first introduced by the International Atomic Energy Agency's International Nuclear Safety Advisory Group, INSAG, (1986) in a post-Chernobyl report and was further expanded by INSAG, (1988). In a further report (INSAG, 1991), the concept of safety culture is discussed in detail. The definition of safety culture proposed by INSAG is:

"Safety culture is that assembly of characteristics and attitudes in organisations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their importance."

This statement identifies safety culture both as applying to individuals and organisations and as attitudinal as well as structural. It also encapsulates the requirement to ensure that actions are commensurate with risk. The concept thus comprises two major components, the framework of organisational policy and managerial action and the response of the individuals working within that framework. INSAG went further and stressed that good practices are not sufficient if applied mechanically and that:

"they must be carried out correctly with alertness, due thought and full knowledge, sound judgement and a proper sense of accountability."

INSAG postulated that the concept could be considered in terms of requirements at the levels of policy, managers and individuals. The views expressed by INSAG, on each of these levels, will be considered in turn:

2.3.1 Requirements at Policy Level (INSAG, 1991)

Here the primary consideration is the legislative framework in which the operation is conducted i.e. the national statutory background, backed up by official advisory, regulatory and enforcement bodies and the adequacy with which these activities are

undertaken. This is mirrored by similar policy considerations within the organisation by the high level policies which create the working environment and condition individual behaviour. Safety policy statements are therefore required, as well as the implementation of these policies within management structures with appropriately delegated responsibility and authority. Such arrangements should include quality assurance, audit and review procedures. The appropriate level of resources must be provided including the appropriate levels of experienced staff. Training, equipment and other facilities must also be provided, as well as a suitable working environment. The arrangements should be self-regulating using the feedback of experience. The commitment of senior management must be asserted and well known, indicating the stance of corporate management and must be demonstrated by senior managers taking a direct interest in safety and frequently communicating their interest to staff.

2.3.2 Requirements at Managerial Level (INSAG, 1991)

Managers must ensure that individual responsibilities are clearly and unambiguously defined and discharged by proper supervision and control. Procedures must be checked and subject to quality control. Managers must ensure that staff are appropriately trained and are competent and understand the significance of their duties and the consequences of mistakes. Encouragement and praise must be given and lessons must be drawn from mistakes. Internal reviews should provide quality assurance for management systems and managers must demonstrate their personal commitment in order to encourage others.

2.3.3 Requirements at Individual Level (INSAG, 1991)

It is the responsibility of staff to respond and act appropriately within the framework already outlined. INSAG propose that this is best achieved by:

“A QUESTIONING ATTITUDE

Plus

A RIGOROUS AND PRUDENT APPROACH

Plus

COMMUNICATION

The result will be a major contribution to:

SAFETY”

INSAG expands on all the actions implied by the above and the implications at the levels of government, corporate organisation, plant and workplace. Finally INSAG, (1991), provide a detailed checklist of safety culture indicators. INSAG therefore provided a definition of what, in their view, constitutes a good safety culture and explained the concept in some detail.

2.4 Other Views of Safety Culture

The Confederation of British Industry (CBI, 1990) produced a report on developing a safety culture, based on the responses to a questionnaire sent to more than 400 firms as well as a detailed examination of the performance of another 50 companies. The culture of an organisation was put simply by the CBI, (1991) as:

“The way we do things round here.”

Whilst this definition is undoubtedly all embracing, it does not specifically direct attention to the structural and attitudinal aspects or the individual and organisational aspects, identified by INSAG. The CBI however, go on to amplify the meaning of safety culture in terms which are similar to those used by INSAG. Safety policies, the provision of resources, identifying responsibilities, standards, quality assurance, the involvement of all employees, communication, training, monitoring and review, are all identified as important factors. The most important aspect is identified as leadership and commitment from the top of the organisation.

The Institution of Occupational Safety and Health (IOSH, 1994), defined safety culture as:

“The characteristic shared attitudes, values, beliefs and practices of people at work concerning not only the magnitude of the risks that they encounter but also the necessity, practicality and effectiveness of preventive measures.”

It is interesting to note that the aspects emphasised by INSAG and by the CBI, had been repeatedly stressed by the UK Health and Safety Executive Accident Prevention Advisory Unit, APAU, in a series of publications, HSE, (1976, 1980, 1981). The term safety culture is not mentioned in these publications but throughout the series, there is an emphasis on almost all of the areas identified by INSAG as forming an essential part of an effective safety culture. HSE stress the need to involve and motivate all staff, the need to raise the level of risk awareness, particularly of the potential consequences of low probability events, the need to ensure adequate resources, to introduce risk assessment with safety measures commensurate with the risks and the need to measure,

monitor and review safety performance. The overall view increasingly being promoted was that the management of safety should be fully integrated with other aspects of management and should be regarded as equally important. In fact this trend reflects the thrust of the Robens Report, (1972) and the subsequent Health and Safety at Work Act 1974, which emphasises the need for a management systems approach to safety, rather than the historical prescriptive approach.

The Advisory Committee on the Safety of Nuclear Installations (ACSNI), Human Factors Study Group, (HFSG), in the third ACSNI Report, Organising for Safety, (HSC, 1993), proposed a further and somewhat expanded definition of safety culture. This definition is in many respects the basis for this research and it is considered in detail in 2.10 below.

2.5 The Social and Political Dimension

During the late 1960s, the 1970s and the 1980s, a series of events influenced the social and political climate and the regulatory authorities, to an increased recognition of the need for an approach in which safety becomes an integral part of the totality of the management system;

“technical excellence is not enough”, (HSE, 1981).

The events which led to various Inquiries including the tip slide at Aberfan;

“..miners devote certainly no more attention to waste tips than householders do to dustbins”, (HMSO, 1966-67),

the accident at Hixon level crossing (HMSO, 1968), the accident at Markham colliery (HMSO, 1974), the Flixborough disaster, (Dept. of Employment, 1975) and the fire on HMS Glasgow (HMSO, 1976), all contributed powerfully to the realisation that the management approach to safety must embrace the totality of the operation.

The incident at Three-Mile Island (Presidential Commission, 1979), indicated that whilst most discussion of nuclear safety focused on the technical aspects, the fundamental issues;

“were people related problems” (Kemeny, 1979).

It was also clear that, in terms of public opinion and political reaction, the consequences of an incident such as that at Three-Mile Island, could be devastating not only to the

company involved but could have repercussions on the entire industry and indeed the technology, which could extend world-wide. HSE, (1981) stated;

“The nuclear industry and parts of the chemical industry are examples where future programmes may be dependent upon managers being able to give convincing assurances that the risks are adequately controlled” and “..there is an overriding need for a safety organisation which takes into account the way human beings actually behave in the situations in which advanced technology places them.”

Whilst many traditional occupational risks have largely disappeared, new technologies, new materials, mass transportation of people and bulk transportation of cargoes, present new potential for disastrous consequences. The accident at Bhopal, the Exxon-Valdez pollution accident (Lindstedt-Siva, 1991) and the capsizing of The Herald of Free Enterprise (Department of Transport, 1987), are all examples which have the capacity to lead to political and commercial consequences far beyond the immediate effects.

2.6 The Need to Understand and Influence Safety Culture

Examination of the reports into several relatively recent incidents, reveals that the factors which have begun to be identified with the concept of safety culture, are fundamental to an understanding of why the incidents occurred and the ways in which the probability of similar events may be reduced. The UK Atomic Energy Authority (UKAEA, 1987), stated;

“It seems certain that a Chernobyl accident could not happen in the UK ... the Chernobyl accident was unique to the BMK reactor design and there are few lessons for the United Kingdom to learn from it.”

The accuracy of this observation, in relation to the technical design of reactors may not be in question but the statement, taken out of context, does give the impression that the wider organisational (i.e. safety culture) lessons may be in danger of being downplayed. However, Lord Marshall, in his introduction to the Report, refers to;

“systematic, persistent and conscious violations of clearly stated safety rules” and went on to ask “..will we become complacent?”

In relation to the Herald of Free Enterprise (ibid), the Inquiry clearly recognised that the causes of the disaster went beyond the immediate causes and related to the overall conduct of the Company;

“..from the top to the bottom, the body corporate was infected with the disease of sloppiness.”

Similarly, in relation to the King's Cross fire, (Department of Transport, 1988), Fennell said the organisation was;

“..not proactive but reactive” and the Inquiry did not see the event as being “..the fault of those in humble places.”

The railway accident at Clapham (Department of Transport, 1989), revealed a similar catalogue of inadequacy in management systems and control, which had been allowed to persist over a considerable time. The Inquiry into the Piper Alpha North Sea Offshore Installation, (Cullen, 1990), found;

“..senior management were too easily satisfied that the permit to work system was being operated correctly, relying on the absence of any feedback of problems as indicating that all was well” and “It is essential to create a corporate atmosphere or culture in which safety is understood to be and is accepted as, the number one priority.”

The dramatic and tragic consequences of all the incidents referred to above, serve to highlight the issues involved and in every case, the background to the incidents was revealed to be a persistently inadequate safety management regime, the roots of which lay in aspects of corporate behaviour embraced by the concept of safety culture. These events received great attention in the media and have, to a significant extent, driven the social, political and regulatory climate in terms of what is acceptable. Arising out of the Public Inquiry into Sizewell B, the HSE published an influential document on the tolerability of risk (HSE, 1988). The document deals not only with nuclear risks but with industrial risks generally and attitudes towards those risks. The document recognises the key role of organisational safety culture in the control of such risks.

2.7 Safety Climate or Safety Culture?

It has already been noted that there is no settled definition of safety culture and some of the definitions proposed have been reproduced above. Similarly, the term safety climate has no settled definition and both terms sometimes seem to be used loosely as though they are interchangeable. A useful distinction is made by Byrom & Corbridge, (1997) in that;

“the term health and safety climate is often used to describe the tangible outputs of an organisation's health and safety culture, as perceived by individuals or work groups, at a particular point in time.”

Similarly, Flin, (1997), suggests that several groups with different cultures may co-exist in a particular environment, it is;

“useful to draw a distinction between the deep underlying cultures and their common surface features which are the work climate.”

2.8 Developments in Safety Theory

2.8.1 Accident Causation

Concurrent with the events described above, theoretical approaches to safety theory have developed an increasingly sophisticated view of the factors leading to accidents and therefore the measures required to avoid accidents. The model of accident causation as a simple sequence of events, the domino theory, was proposed by Heinrich (Heinrich et al., 1980). Accidents were caused by unsafe conditions or unsafe events and by eliminating them the accident could be avoided. This approach was developed by Bird and Loftus, (1976), who introduced the distinction in the chain of events, between basic causes and immediate causes. Their model reflected multiple causes and multiple opportunities for control. Bird and Germain, (1985) also drew attention to the need for management systems to be in place, which would avoid the basic causes, by effectively providing the mechanism for intervention at the pre-contact stage thereby avoiding the loss situation. Nevertheless, the limitation of these models is the likelihood that they will be used simplistically and erroneously, in a purely linear way, to end an investigation once a single cause has been identified. This was referred to by Rasmussen, (1987), as the stop rule.

The traditional approach to the management of safety described by Booth & Lee, (1995), was to attribute a primary cause either to an unsafe act or an unsafe condition and devise a new rule to forbid the act or a technical solution to make conditions safe. A more sophisticated approach to multi-causal analysis is provided by the Management Oversight and Risk Tree, MORT, (Johnson, 1980). This technique offers a large range of accident initiating events related to controls, management systems and information systems but whilst it offers a much more penetrating analysis, it can result in great complexity.

2.8.2 Human Error

2.8.2.1 Skill/Rule/Knowledge Based Errors and Violations

The human error classification proposed by Rasmussen, (1987), was based on skill-rule-knowledge errors. Skill based errors involve simple slips, (actions not intended, of which the perpetrator is aware), and lapses, (unconscious mental errors, of which the perpetrator may become aware later). Rule based errors result from a mistaken application of a rule or a procedure. Skill based errors are usually revealed immediately because of rapid feedback, whereas rule based errors are more difficult to diagnose because the consequences may not be obvious (Glendon & McKenna, 1995). Knowledge based errors arise when a plan based on the application of knowledge is misconceived. Skill based and rule based errors usually result in active failures (it is usually clear what has gone wrong and who is involved). Latent failures occur at the level of knowledge based errors and are most important from the point of view of potential loss. (See section 2.8.2.3 below.)

Rasmussen's classification did not extend to violations. Reason, (1990), proposed a generic error modelling system, following Rasmussen's skill-rule-knowledge classification but also introduced the concept of errors in the execution stage (skill based) and in the planning stage (rule or knowledge based). Errors in the planning stage are inherently harder to detect. In addition there are violations, which are deliberate deviations.

Some catastrophic incidents have resulted when a simple error occurs, in an unforgiving environment (Reason & Mycielska, 1982). The Kegworth air crash, (Department of Transport, 1990), was an example in which the trial and error rule for determining which engine had failed, caused the pilots to shut down the wrong engine with disastrous results. Reason, (1990) argues that people gamble on high frequency alternatives (events known to have happened before). This is generally successful but it is a gamble which can go wrong.

2.8.2.2 Forcing Functions

A forcing function is an important concept described by Lewis & Norman, (1986), as;
 "something that prevents the behaviour from continuing until the problem has been corrected."

This concept is useful in preventing some skill based errors and can be seen in interlocks or in a design which prevents an item from being assembled the wrong way (Glendon & McKenna, 1995).

2.8.2.3 Active and Latent Failures

Reason, (1990), drew a distinction between active and latent failures. Active failures are those made by the persons at the work-face, whereas latent failures are those which are removed by time and space from the operation. Latent failures can therefore be hidden in the organisation until triggered by some event or set of circumstances and the potential consequences can possibly be much more severe than for active failures. The triggering of such an event is captured by Reason, (ibid., 1990), in the metaphor of a resident pathogen which is dormant until combined with some other agent, when an active failure becomes manifest. According to Perrow, (1984) the more complex, tightly coupled, and interactive the organisation or system, the more likely it is to conceal a resident pathogen (Glendon & McKenna, 1995).

Examples of latent failures, (Mason, 1992, cited in Glendon & McKenna 1995), include the following:

- *Poor design of plant or equipment*
- *Ineffective training*
- *Inadequate supervision*
- *Ineffective communications*
- *Uncertainties in roles and responsibilities*
- *Management failure to provide adequate safeguards*

2.8.2.4 The Hale/Glendon Model

Hale & Glendon, (1987), developed Rasmussen's skill-rule-knowledge classification system into a model of human behaviour in the face of danger based in inputs and outputs (The Hale-Glendon model). Assuming danger is present, the model takes account of behaviour in hazard identification, (input stage), the assessment or processing stage, (essentially risk assessment), and the selection and adoption of measures to reduce the risk, (output stage). The model includes a feedback loop since the process is iterative. The model allows identification of hazards and subsequent action at skill, rule and knowledge levels. In effect, the model may be applied to

individual behaviour within the context of an organisation, to take account of the risk assessment process, individual capacity for errors and violations, errors at different levels in the organisation and latent and active failures. The model demonstrates the need for an approach to safety management which embraces both structural and individual considerations.

2.9 The Increasing Significance of Safety Climate/Culture

The development of legislation from a mechanistic, prescriptive approach, towards an objective setting style, the theoretical developments in the understanding of accident causation, human error and organisational culture, together with the circumstances leading to a significant number of major incidents, have all resulted in the present emphasis on the socio-technical dimension in the management of health and safety.

2.10 ACSNI Report – Organising for Safety

The Advisory Committee on the Safety of Nuclear Installations (ACSNI) Study Group on Human Factors, produced a report (HSC, 1993), the Third ACSNI Report, on Organising for Safety. A central purpose of the third report, was to describe the evidence on which the concept of safety culture is founded, measured and improved. The study group proposed a somewhat expanded definition of safety culture:

“The safety culture of an organisation is the product of individual and group values, attitudes, perceptions, competencies and patterns of behaviour that determine the commitment to and the style and proficiency of, an organisation’s health and safety management.

Organisations with a positive safety culture are characterised by communications founded on mutual trust, by shared perceptions of the importance of safety and by confidence in the efficacy of preventive measures.”

It is interesting to note the reference to a *positive*, rather than a *strong* safety culture. Presumably, if a culture is something that;

“manifests in an organisation because of the natural tendency over a period of time for groups of people to conform with each other and establish shared attitudes, perceptions, beliefs, values, social behaviour and accepted work practices” (Dalling, 1997),

then any organisation or group, which has been established for some time, will possess some form of safety culture. It would seem self-evident that such a culture could be

positive or negative in the sense that it would be likely to predispose the organisation to a good or a poor safety performance. Safety cultures are frequently described as strong, in the sense that they are conducive to a good safety performance but a culture may also be strong in the sense that it is simply well entrenched, founded on strongly held values and beliefs and is resistant to change. This could be the case with either a positive or a negative safety culture. The use of the adjective strong is therefore an inadequate description. To avoid ambiguity, it is assumed in this thesis, that a strongly positive safety culture is the desirable objective and that a safety culture which can be so described, is blessed with an abundance of attributes which are generally believed to be associated with a good safety performance.

The review of research conducted by ACSNI (HSC, 1993), identified several factors which would affect the safety culture of an organisation and its safety performance. However,

“the largest and most convincing group of factors influencing safety was that which could be broadly grouped under the heading of management labour interactions.”

This group includes factors such as senior management commitment, management style and visibility, communications and production pressures. Other factors with a bearing on safety culture and safety performance were training (of workers, supervisors and managers), housekeeping and the working environment, job satisfaction and the composition of the workforce. Clearly many of these factors are interrelated. A management that is committed to safety and with a caring style, is more likely to place emphasis on training and the working environment and job satisfaction is likely to tend to be greater in such an environment.

A particularly important characteristic of a positive safety culture is related to the perception of risks and attitudes towards risks and safety. Such characteristics are unlikely to be independent of the factors listed above. The research findings related to all of these factors will now be discussed.

2.10.1 Senior Management Commitment

Most of the authoritative advice on safety management stresses the importance of senior management commitment. (HSC, 1993, 1990, CBI 1990, HSE 1976, 1981, 1991 etc.)

Commitment can manifest itself in many ways including management visibility and

interest, sincerity of concern, the profile given to safety and the safety function and the resources devoted to safety. It is evident that the depth of management commitment will be a major influence on most of the other factors referred to above, such as training, good housekeeping, working environment and communication. It is therefore not surprising that the ACSNI Human Factors Study Group (HFSG), having reviewed all the literature, should place management commitment at the forefront of any consideration of safety culture.

According to HFSG, the scale of the financial and human resources devoted to safety and the status thereby accorded to them in the organisation, is a factor which has consistently been demonstrated to differentiate organisations with good safety performances from those with bad safety performances. This consideration extends to safety committees (which also has a bearing on the participative style of management) and to safety practitioners. All of these issues were identified by Zohar, (1980), Brown & Holmes, (1986) and Dedobbeleer & Beland, (1991), as important factors in studies of safety climate. It is a concomitant of management commitment, that the management of safety must be a clearly identified line management responsibility. This is forcibly expressed in HSE (1991) which states;

“health and safety is a management responsibility of equal importance to production and quality”

and that health and safety must be regarded;

“as a Boardroom issue.”

2.10.2 The Style of Management

It is also emphasised that a humanistic approach and a participative style of management, in which the workforce are genuinely and meaningfully involved, is an essential part of a good safety culture. The link between leadership styles and culture is recognised by Brown, (1992);

“Effective leadership and workable organisation design and development programmes must be based on sensitivity to, and understanding of, culture. Excellent leaders are not merely aware of their organisation's basic assumptions, they also know how to take action to mould and refine them.”

Evidence from many studies of the relationship between productivity and different styles of management, indicates that more democratic approaches are likely to be more

successful than an autocratic approach. This simplistic differentiation in styles has been variously described as *caring* or *controlling* and as either *employee centred* or *production centred*. In a study of fourteen plants, conducted in the US by Smith et al., (1978), it was noted that lower accident rates were correlated with a humanistic management style. Similarly, DeMichiei, (1982), found high accident rates to be a feature of plants in which little interest was shown by management, in the welfare of workers whereas, in plants with low accident rates, management worker relationships were characterised by greater involvement and openness. HSE, (1991) stated that worker participation complements control and encourages “ownership” of health and safety policies. Indeed the HSE recommends an approach to the organisation of safety management based on:

- *Control*
- *Co-operation*
- *Communication*
- *Competence*

The co-operative participation of the workforce in a proactive approach to safety is therefore seen as an essential component of an effective strategy. A detailed review by the HFSG of the research evidence from Japan, is reported in HSC, (1993), and this evidence supports, in various studies, the relationship between a democratic style of management and better safety performance.

2.10.3 Management Visibility

The personal profile of managers is seen to be an important element in a good safety culture (HSC, 1993). This is a particularly effective way of demonstrating their personal commitment and a lack of visibility in this respect, will almost certainly provide an even more powerful negative message. The commitment must be perceived by the workforce as sincere. Edicts and pronouncements will not, in themselves, serve this purpose. HSE, (1981) notes;

“It is not enough to declare certain safety goals. People have to be convinced of their importance and that the organisation intends to achieve them. The cue will be taken from the top.”

The visibility of managers within the workplace and the relative informality of their relationship with employees, is a function of the democratic style discussed above. Such

an approach is supported by Gaertner et al., (1987), who found a positive correlation between good safety performance and a “positive safety climate”, which included an openness in management and walkabout by management as well as good communications. HSE, (1991) suggests that visible and active leadership of senior managers is necessary and that by their behaviour and practice they will communicate the beliefs which underlie their policy.

2.10.4 Communications

Good and effective communications between management and employees and supervisory levels, as well as good horizontal communications, are seen as a necessary component of a good safety culture. The findings of the studies, to which reference has already been made, by Gaertner et al., Smith et al. and Demichiei, all support the importance of frequent and informal communication. Communication is also one of the essential elements in the approach recommended by HSE, (1991). Communication here refers to information flows, however communicated and the ease with which communication takes place will again be a function of the management leadership style. As indicated by Booth, (1993), communication must operate two ways, at all levels to be effective. It was found by Ryan, (1991), in studies in the US nuclear industry, that the effectiveness of communications, was the most significant predictor of safety performance. The next most significant factor was organisational learning. Both these factors are relevant not only to safety but to all aspects of management, which means, as pointed out by Booth, (1993), that to make managers manage safety better, it is necessary to make them better managers. In a study within the UK railway industry, of the impact of communication on safety culture, Horbury, (1997), demonstrated that the existing safety culture was damaged by attempts to use communications to improve it, because of the poor and ineffective nature of the communication process. This illustrates that it requires more than communications per se, to make a positive effect on safety culture, it requires good and effective communications. It may be noted that the HFSG definition of safety culture refers to “communications founded on mutual trust.”

An essential aspect of an organisation with a good safety culture, is an ability to learn from accidents and near misses. Such learning can only take place if the relevant knowledge about such incidents is first obtained and then the lessons are effectively communicated. All of this requires an effective communication system based on trust.

Unless trust exists, it is unlikely that complete information will be forthcoming, particularly in relation to near misses. Of considerable importance in establishing and maintaining trust, is the organisation's reaction to an accident, particularly with regard to the issue of blame. The fact that this issue poses a dilemma for management is recognised by Pidgeon, (1993), who recognises that the need for sanctions must be balanced against the requirement to encourage the volunteering of information. According to Turner et al., (1989), the only justification for blaming careless workers is that it prevents the blame from falling elsewhere.

In the discussion of the importance of communications it is appropriate to refer to organisational learning, since this can only be efficient where there are effective information flows. According to Glendon, (1995), organisational learning is the process whereby those in an organisation learn to change their characteristic ways of thinking and acting as a result of shared experience, addressing problems mutually and sharing in the life of the organisation. Organisational learning is therefore important, not only to safety but to every aspect of organisational life and is essential for every organisation desiring to survive.

2.10.5 Pressure for Production

HSC, (1993) states that there is a risk/benefit trade-off when excessive production pressures are exerted and that various studies have demonstrated higher accident rates for workers receiving a production bonus or on piece work, when compared with workers on time based payment. Often the pressure placed upon supervisors by senior management, can tend to an over-optimistic assessment of risk, particularly in relation to risks which are familiar, which supervisors often underestimate. (Ostberg, 1980). This tendency is likely to be reinforced by the supervisor noting management approval, if all goes well. Errors are more likely when workers are under stress. The Clapham rail crash (Department of Transport, 1989), provides a stark example of time pressures and fatigue leading to disaster. Matthews et al., (1994), found from a number of studies, that stress predisposed drivers to a greater risk of vehicle accidents.

It is appropriate here, to refer to the attitude dimension of "locus of control" (Rotter, 1966). Some individuals are said to have "internal" loci of control and some "external" loci. The externals tend to regard the outcome of their efforts as being outside their

control, whereas the internals are more likely to see the outcome in terms of their own efforts. Those with external loci of control see the events that define their lives as being controlled by others and are generally believed to be less able to cope effectively with stressful situations. Consequently, externals, with a strong belief in their own ability to control events, may be frustrated if they perceive their powers of discretion being reduced by automated equipment or by what they may regard as an excessively bureaucratic safety procedure. (HSC, 1993).

2.10.6 Training

Another element in the HSE's recommended approach to the management of safety is competence, at all levels and in all roles. It is unlikely that this can be achieved without training. Training was also identified in the work of Zohar, (1980) as being the most highly predictive factor, as perceived by the workforce, in distinguishing plants with a good safety climate. Other researchers have found that good safety performance was related to the provision of induction training (DeMichie, 1982), the favourable views of staff on the training they had received (Pfeiffer et al., 1976) and the amount of safety training received (Smith et al., 1978). The third ACSNI report (1993), drew attention to the need for leadership training for supervisors, as well as the need for training to increase awareness and understanding of hazards.

The ACSNI first report (HSC, 1990), dealt specifically with training and reviewed the existing literature in detail. Its comments are therefore particularly valuable. It states that training should take account of changing conditions, past experience and new developments and should therefore be under continuous review. They also recognised that the level of technical sophistication in high technology industries is so sophisticated that the major source of accidents now resides in human error. They took the view the safety must be inextricably woven into the entire tapestry of training and that care should be taken to ensure that training took account of the capacity for latent failures to be introduced into the system by those in jobs removed from the operational work-face. In summary they suggested:

- *Training should be based on assessed need and task analysis*
- *Training should be specified by line management and as far as possible, monitored independently*

- *Trainee assessment should be objective and independent and with a minimum pass standard*
- *Authorisation should remain a local management responsibility*
- *Authorisation should be subject to continuous assessment*
- *Training should embrace the needs of the whole organisation, including senior management*
- *The training organisation should be of such a size that it can function efficiently*

It is clear from all of the above, that the commitment of senior management is essential if training is to achieve these desirable objectives.

2.10.7 Housekeeping and Working Environment

As pointed out by HSC, (1993), the role of the physical environment in facilitating safe behaviour is extremely important and one of the easiest factors to control. In a study of accident rates in different departments of a tractor assembly plant, it was found by Keenan et al., (1951), that a clean and comfortable working environment was the most significant predictor of safety performance. This relationship remained valid after allowance had been made for the inevitable differences in working methods and processes between different departments.

Physical conditions of work, such as poor environment, noise, extremes of temperature and poor ergonomic design all contribute to a poor working environment, which in turn contributes to stress and may increase the likelihood of error. The second ACSNI report (HSC, 1991), emphasises the role of ergonomics in error reduction, with particular reference to lighting, noise and climatic conditions. They also stress the importance of the clear presentation of information to operators.

2.10.8 Job Satisfaction

Job satisfaction cannot be regarded as a stand alone factor but must be interdependent with many of the aspects already discussed such as management style, housekeeping and the working environment, communication and pressure for production. Individual factors, social factors, cultural factors, organisational factors and environmental factors all contribute to this complex concept (Mullins, 1996). The causes of job satisfaction may therefore arise from factors inside or outside work. One of the major adverse influences on job satisfaction, work performance, productivity, absenteeism and

turnover, is stress (Robbins, 1993), which, according to McKenna, (1994), can be created by any situation seen as burdensome, threatening, ambiguous or boring. A number of studies have been conducted which have a bearing on the relationship between job satisfaction and safety. It was found that an attitude scale covering a number of aspects of job satisfaction and social adjustment was predictive of accident performance amongst bus drivers (Bose et al., 1969). In a study conducted at Sellafield, it was also found by Lee, (1997), that individual job satisfaction was a powerful predictor of their accident history. Lee suggests that safety is a vulnerable target for the discontented or bored worker because it is perceived as something dear to them i.e. management. Job satisfaction implies that workers have confidence in the arrangements for ensuring their safety and a study by Marek, (1987), involving workers on Norwegian oil platforms, found that their perception of the effectiveness of specific safety measures was the most significant predictor of their view of various risks associated with hazards on the platforms.

2.10.9 Workforce Composition

The review of the evidence by HFSG (HSC,1993), led them to conclude that the proportion of older, more experienced, socially stable workers in the group is a significant factor. Such workers tend to have fewer accidents, less absenteeism, lower turnover and all things being equal, there is advantage in having a proportion of such workers in the group.

Another feature which must be noted in relation to groups and which may have an important bearing on safety, is the phenomenon of “groupthink.” This term was introduced by Janis, (1972) in describing the decision making process of those involved in planning the Bay of Pigs invasion of Cuba. It is a reference to the fact that a cohesive group may be inclined to inadequate evaluation of issues facing the group. Some of the features of this process could be shared illusions of invulnerability, a tendency to reject advice which does not conform to preconceived views but to accept supportive views uncritically and a reluctance to deviate from what is perceived to be group consensus. It is evident from this, that excessive homogeneity in the group may bring undesirable consequences. One method of countering this problem would be to ensure that the group contained an appropriate representation of differing views and perspectives and was exposed to external influence and moderation.

Having reviewed the factors identified by HFSG (HSC, 1993) as most significant in contributing to a good safety culture, some other issues will now be considered.

2.11 Monitoring and Reviewing Safety Performance

No organisation can be confident of the efficacy of its safety arrangements unless it has some means of subjecting them to ongoing scrutiny and review. HSE, (1991) recommends the feedback loop of audit and review as an essential part of the system for the management of safety and define the audit process as;

“the structured process of collecting independent information on the efficiency, effectiveness and reliability of the total safety management system and drawing up plans for corrective action.”

Clearly, the means used to measure safety performance may be reactive, i.e. measure or assess what has already happened, or proactive, i.e. measure or assess the status of the management systems which are intended to ensure safety. It is not intended here to review the various auditing methods presently available but the organisation which is the subject of this thesis, used the International Safety Rating System, (ISRS) and therefore it is appropriate to consider the literature relating to this system in some detail. ISRS represents a structured approach to the management of safety, comprising 20 elements including for example, *leadership, employee training, emergency preparedness, engineering controls, accident/incident investigation* and *communications*. (Bird & Germain, 1985). The desirable management approach to safety in each of the elements, was originally derived from factors which discriminated between good and bad firms in studies of safety management. A study was conducted by Gaunt, (1989), to assess the effect on safety, profitability, morale, turnover and other aspects of management performance, in organisations that had recently introduced ISRS. He used a 7 point Likert scale to assess 34 organisational performance factors and found a generally positive effect, the degree of benefit being a function of the organisation's achievement in the ISRS audit. Respondents reported improved safety attitudes, morale and work methods, reduced absenteeism and improved quality. However, a controversial and contested paper by Eisner, (1991), suggested a poor correlation between ISRS audit ratings and safety performance in South African mines.

In a research project sponsored by the HSE, Smith, (1992), found that ISRS audit results were sufficiently robust to be used with conventional quantified risk assessment (QRA) techniques, to modify the QRA, in a way which allowed management and organisational factors to be taken properly into account.

Following the formation of Nuclear Electric from the former CEGB in 1989, the company introduced a management enhancement programme that involved implementing improvements in the management of nuclear safety. (Gibson & Low 1994). The programme included inter alia, the introduction of ISRS to measure the extent and quality of safety management, using systematic audit of site activities against published criteria. It was claimed that after five years experience, ISRS was providing a pro-active feedback system, bench-marking the company's safety performance against best international practice and enabling corrective measures to be put in place before any shortcomings result in losses to process, plant and people. Interestingly, Another generating company formed from the CEGB at the same time, National Power, also introduced ISRS but found that three years after its launch, standards being achieved were variable and generally poor (Davison, 1997). ISRS had originally been introduced in a top down fashion, with a launch by senior management. The station managers, who were the users of the system claimed that ISRS was too prescriptive and required behaviours which were incompatible with a company which was heavily involved in decentralisation, devolution of authority and empowerment. As a result they were not committed to the system. Subsequently the managers were drawn into a working group to identify a more suitable system. A station manager on the working group presented their findings to his colleague managers and they agreed to use the Royal Society for the Prevention of Accidents (RoSPA) Quality Safety Audit (QSA) system. Commitment and ownership had been achieved by involving and consulting them. One may speculate as to the relative effects of the inherent qualities of the rival systems and the different methods by which they were introduced.

2.12 Risk Perception and Attitudes Towards Risk in the General Population

Insofar as safety culture is founded on the attitudes of individuals, an obviously important component of the attitude set is individual attitude towards risk. Individual perception of risk is governed by personal make-up and experience, Some serious risks may be ignored because people are indifferent to them (Royal Society, 1983). It was

found by Lichtenstein et al., (1978), that when people were asked to judge the frequencies of a range of risks, their assessments were different to the actual frequency of the risks, rare adverse events tending to be overestimated and more common events tending to be underestimated. Different groups of people were asked to rank 30 risks (Slovic et al., 1979). There were some interesting differences between the groups with, for example, women and students ranking nuclear power as number one and experts ranking it at twenty. A study commissioned by the HSE into public attitudes towards risks (Prescott-Clarke, 1982) produced similar results.

Perceptions of risk are influenced by the degree to which individuals believe that they or those close to them, may be affected (Green, 1979). And the tolerability of the risk is governed by complex social processes in which scientific and legal requirements are associated with social acceptability influenced by media and political considerations (Glendon & MacKenna, 1995). Booth, (1990), contends that the maximum tolerable risk for death for risks with delayed effect should be greater, to take account of the risk of death from other causes.

2.13 Risk Perception and Attitudes Towards Risk in the Workplace

In exploring further the individual attitude towards risk, specifically in relation to the workplace, the perception of risk will first be considered and then attitudes to risk.

2.13.1 The Perception of Risk

The ACSNI Human Factors Study Group points out (HSC, 1990), if employees are to behave safely and avoid risks;

“the employee must have an accurate perception of the risks.”

Nevertheless they conclude;

“misperceptions of the seriousness of risks occur frequently and at all levels of an organisation” and “The most common cause is over-familiarity leading to overconfidence.”

In estimating risks, biases are introduced (Hale, 1987, Hale & Glendon, 1987):

- *Availability - greater weight is given to what is known, recent or frequent*
- *Overconfidence – lack of appreciation of how limited understanding actually is- too much faith in professional's judgement*

- *Desire for certainty – easier to cope with than ambiguity and can result in risks being played down*
- *Anchoring – views become resistant to change*

HSC, (1993) summarises as follows, the attributes of hazards that influence perceived risk (based on public surveys) but which are taken to apply also to the workplace:

<i>Benefit</i>	<i>High – Low</i>
<i>Volition</i>	<i>Voluntary – Involuntary</i>
<i>Severity Potential</i>	<i>Ordinary – Catastrophic</i>
<i>Origin</i>	<i>Natural – Man-made</i>
<i>Effect Manifestation</i>	<i>Personal Threat – Societal Threat</i>
<i>Time Scale</i>	<i>Immediate – Delayed</i>
<i>Controllability</i>	<i>Controllable – Uncontrollable</i>
<i>Familiarity</i>	<i>Familiar – Unfamiliar</i>

Individual perceptions of risk tend to be a function of where they are seen on the scales suggested above.

Several studies have been conducted with different workers to determine their perceptions of risk. Hale, (1971), compared the risk awareness of workers with objective risk estimates and found that awareness was a function of the recency and frequency of accident experience. Other studies (Douglas & Wildavsky, 1982, Douglas, 1985), have shown that people adopt the risk perception values and norms of the group to which they belong. It was found by Zimolong, (1985), that workers in the construction industry, significantly underestimated the risks of their own trade. Support for the view that familiarity leads to underestimation of risk was obtained by Rushworth et al., (1986) in studies of workers involved in the maintenance and cleaning of very large bunkers in coalmines.

There is evidence that the appreciation of risk by some workers is greater than others and that this attitude is enduring (Hale, 1971, Ostberg, 1980). Ostberg found significant differences in the estimation of risks between different groups of forestry workers. Trainers were found to overestimate risks but supervisors significantly underestimated the risks.

2.13.2 Attitudes to Risk

According to Lee, (1996);

“an attitude is a relatively enduring tendency to behave in particular ways towards some aspect of the environment – a stable predisposition. Attitudes are subordinate to values and superordinate to risk perceptions.”

Cox & Cox, (1991) argue that;

“constructive attitudes among the workforce, because they result from all other contributory features, are probably the most important single index of the effectiveness of a *safety culture*.”

Positive attitudes towards safety have been found to correlate to safety performance. Marcus, (1988), found that US nuclear power plants with a good safety climate and positive employee attitudes towards safety, had fewer accidents and human error events than those with poor safety climates. Olearnik & Canter, (1988) found a positive correlation between employee attitudes towards safety and accident performance, in UK steel plants. Levine et al., (1976) conducted a survey in a US aircraft carrier, using a number of scales addressing different aspects of safety attitudes. It was found that there was significant correlation between an *adventurousness* scale and individual accident record. Similar results were found by Andriessen, (1978) amongst construction workers erecting high buildings. Correlations were obtained between safe behaviour and two dimensions within it, identified as *carefulness* and *initiative*, and various motivating factors. It was found that management (or the supervisor), had the greatest influence on safe behaviour and the results also demonstrated that production pressure can conflict with safety.

Lee et al., (1993) used a survey of attitudes in a nuclear reprocessing facility to measure safety climate. The technique employed involved the use of focus groups, (rather than the researcher), to assist in identifying factors of concern to the staff. The results were used to develop a questionnaire. The analysis of the responses produced 19 factors which could be grouped to relate to 9 domains relevant to safety (e.g. training, safety rules, job satisfaction etc.). It was demonstrated that responses to 17 of the 19 attitudes correlated with individual accident experience. Techniques conventionally used to assess safety culture may be based on audits of *inputs* (e.g. management systems and procedures) or *outputs* (e.g. accident rates, physical conditions) but such measures are coarse and changes to inputs may take some time before an effect is observed in

outputs. The attitude survey therefore does seem to offer a useful additional means to assess the safety culture with the possibility of suggesting interventions which could effect improvements.

2.14 Influencing Attitudes and Behaviour

The factors which are believed to mould, influence and change attitudes and behaviour will now be considered.

2.14.1 Changing Attitudes

“Since attitudes are formed by communication and experience, they must be changeable in the same way...” (HSC, 1993).

Exhortation however is unlikely to succeed because of deeply embedded attitudes. Behaviour and attitude change is the subject of a vast literature beyond the scope of this review but in terms of safety, some discussion is appropriate. Communication is one means of promoting change, although attention must be paid to the source, the message, the medium and the receiver (Lee, 1986). Problems often arise because the source of the message speaks a different *language* to the recipient. Face to face communication is generally more effective than electronic communication and written messages aid comprehension. Persuading a high status member of the group will often result in others following. If the source is not credible or relies on *power* to persuade it may result in *compliance* but not *conformity*. Safety propaganda campaigns are unlikely to succeed unless backed up by other measures, such as training, (Hale, 1974). Attitudes of employees are developed in response to the socio-technical system in which they find themselves, which suggests that another obvious way of inducing change is to change the work situation. For example changing procedures, safety rules or work conditions in response to needs indicated by an attitude survey (Lee, 1997).

2.14.2 Applied Behaviour Management

A further way of changing attitudes, is to use the technique of Applied Behaviour Management and effect a change in behaviour, which will in turn result in a modification in attitude. The theory of reciprocal determinism (Bandura, 1977) postulates that;

“the situation people find themselves in will influence both their behaviour and their attitudes. People’s behaviour will influence both their attitudes and the situation and that people’s attitudes will influence their behaviour and the situation.”

There is mutual interdependence between attitudes and behaviour and if actions are incongruent with attitudes then people generally make an accommodation. This is the basis of the present general acceptability of the wearing of seat belts and hard hats, which was initially founded on legislation. Exhortation had previously met with a relatively poor response. The importance of value congruence was demonstrated by Meglino et al., (1989), who found that workers were more satisfied and committed when their values were congruent with those of their supervisors and that the effect of value congruence on organisational commitment was greater for longer tenured employees. A methodology for the implementation of a behaviour based approach is described by Cooper, (1994) and an example of the methodology in use, is described in Duff et al., (1993).

2.15 Organisational Structures and Culture

This thesis is concerned with the ways in which safety culture may be moulded, influenced and changed by the various forces acting upon and within the organisation. It is therefore appropriate to review the relationship between culture and organisations. This will be approached by first considering the development of organisational theory and then going on to consider organisational culture in a wider context.

2.15.1 Organisation Structures

Most of the literature deals with safety culture in the context of the *socio-technical system*. It is appropriate to comment briefly on the development of organisational theory, with a particular reference to the organisational structures and systems which are the subject of this thesis. The classical origins of organisation theory relate to scientific management and to bureaucracy.

2.15.1.1 The Scientific Approach

Taylor, (1947), originated what became known as scientific management. His work was first published in 1911 and was based initially on the classical studies at the Bethlehem Steel Corporation. He believed that the best and most efficient organisation would result from breaking down tasks, identifying the best way of performing the task and

structuring the organisation in the optimum way to perform its function. He believed that workers would benefit from good wages and good working methods and that optimum structures demanded clear division of responsibilities. The approach depended on time and motion studies and eliminating all unnecessary tasks and movements. In effect, the organisational approach to work he proposed was akin to a well designed machine and it could be argued that the workers were an integral part of that machine. Although this approach has since been the subject of much criticism, generally on the basis that it takes insufficient account of human needs and behaviour and on the grounds that workers are treated as robots, his legacy continues in relation, for example, to payment by results, work study and production control.

2.15.1.2 Bureaucracy

Weber, (1964), referred to bureaucratic structures, in which the organisation itself would continue to function in the same way, independent of changes in post-holders.

Features of bureaucracies were: (Stewart, 1986)

- *Specialisation* (of roles)
- *Hierarchy of authority* (defined levels of authority)
- *System of rules* (stable established procedures)
- *Impersonality* (Decisions not arbitrary but rule based)

Weber himself believed that bureaucracy was the most efficient form of organisation:

“Experience tends universally to show that the purely bureaucratic type of administrative organisation – that is, the monocratic variety of bureaucracy – is, from a purely technical point of view, capable of attaining the highest degree of efficiency and is in this sense formally the most rational known means of carrying out imperative control over human beings. It is superior to any other form in precision, in stability, in the stringency of its discipline and in its reliability.”

Although the term bureaucracy is used often in a pejorative sense, it is clear that almost all organisations of any size will have some of these features to some degree. However, it may be argued that there is a political need, particularly in public sector organisations, for uniformity of treatment, regularity of procedures and accountability for their operations (Mullins, 1996). The corollary is that bureaucracy can be criticised for over-emphasis on rules, lack of flexibility, officiousness and ossification. In a similar way to the scientific approach to management, bureaucracy could be said to ignore the human dimension.

2.15.1.3 *The Human Approach*

The human approach to organisation theory, was introduced by the classical Hawthorne experiments and by the well known works of Maslow, (1943) on the hierarchy of human needs, Herzberg et al., (1959) with the motivation-hygiene theory and McGregor, (1987) with his *Theory X* and *Theory Y* approach.

The work of Woodward, (1980), based on a study of 100 manufacturing companies, suggested that the most successful organisational structure for particular companies, was a function of the technology employed by the organisation. The firms being studied varied in their production processes between small batch, mass production and process production, whilst the organisation structures varied between line management, functional management and line/staff management. The studies indicated that the more complex the technology, the greater the number of managerial levels, that the span of managerial control increases with a move towards mass production and decreases with a move towards process production and that numbers of clerical and administrative staff tended to increase with technical complexity. The study also indicated that the most critical function (from amongst production, marketing and development functions), also depended on the nature of the production process. Perrow, (1970) suggested that the optimum organisation would depend on the predictability of the process and the extent to which problems could be solved by predetermined procedures.

2.15.1.4 *The Systems Approach*

The systems approach is an attempt to combine the earlier structural and human concerns into a consideration of organisations peopled by human beings. Organisations may be thought of as systems, with inputs and outputs with an intervening process converting the inputs into outputs, thereby achieving the purpose of the organisation. Every system must have a boundary which determines both what is inside and outside the system and each system may contain sub-systems within it. A corporate organisation may have a departmental system “nested” within it and that in turn, may have a unit level system nested within it. Waring, (1996) The normal business organisation is an open system, in the sense that it must react with the environment or outer context. The environmental influences may include:

- *Customers*

- *Suppliers*
- *Competitors*
- *Government*
- *Shareholders*
- *Financial institutions*
- *Technological progress*
- *Trade Unions*
- *Etc.*

A sub-system within the organisation will be influenced by its immediate company environment but may also be subject to interactions with environment outside the company.

2.15.1.5 The Socio-Technical Approach

The concept of socio-technical systems was introduced by the work of the Tavistock Institute of Human Relations (Trist et al., 1963) in studies in British coal mines in relation to changing technology and its effect on work groups. The study pointed to the existence of sub-systems within the organisation: (Mullins, 1996)

- *The technological sub-system*
- *The formal role sub-system*
- *The sub-system of individual feelings and sentiments*

The socio-technical system is therefore concerned with both the technical aspects of the system and the psychological and social factors relating to those working within the system.

An important study by Burns and Stalker, (1966), considered the effect of different kinds of environments on organisation and performance. They identified two types of organisation, *mechanistic* and *organic* which they postulated as polar extremes. The mechanistic organisation is represented as more rigid, with many of the characteristics of bureaucracy and more suited to a stable environment. The organic organisation is represented as more flexible and more responsive to a changing environment. A mechanistic organisation is characterised by a hierarchical command structure, role specialisation and defined procedures, whereas an organic structure is characterised by a network structure of control, lateral communication and knowledge and competence not necessarily associated with hierarchical position. In an organic structure, staff are

skilled at solving a variety of problems not at repetitively performing a specialised activity. Burns and Stalker make it clear that the two types of organisation are a polar extremes and that organisations will have characteristics of each in varying degrees.

A further development of this work by Lawrence and Lorsch, (1969) looked at the relationship between the external environment and departmental organisation. They considered the amount of differentiation between departments in respect of the way they operated and were organised as well as the amount of integration or collaboration between departments. They found that whilst research departments took a long view and were least bureaucratic, production departments were dealing with real time problems and when operating in a stable technical environment, had the most bureaucratic structure.

All of the theoretical approaches and empirical studies outlined above have their evident strengths and limitations. It is clear that most organisations exhibit, to a greater or lesser degree, various features identified in these studies. In other words there is no single best solution to the structure of organisations and that in the real world, the forms organisations take will vary according to their history, their technology, their function, the external environment and all the other forces and pressures to which they are subjected. Much of the early classical organisational theory developed by Taylor, Weber and others, was dominated by the search for a single *best way*. Contingency theory is based on the premise that there is no one best way and that the best form of organisation is dependent on the particular set of contingencies faced by the organisation (Child, 1988).

2.15.1.6 The Human Activity Systems Approach

The socio-technical model is described by Waring, (1996) as;

“clockworks plus humans”.

He accepts that the model recognises that technology and people interact and that human factors are recognised as being important in communication, training and emergency responses, for example. He contends however, that the socio-technical approach only addresses the formal functional aspects of control, communication, monitoring and implementation. In his view, the model assumes that humans are amenable to rapid behaviour modification by exhortation, training, incentives,

punishments etc. This can result in initiatives being taken, which involve great effort and expenditure but which still fail to gain the support of the workforce.

Waring proposes the *human activity systems* approach in which an unlimited range of hard paradigms (e.g. formal system, control, fault trees etc.) and soft paradigms (e.g. motivation, learning, culture, power etc.) can be combined. Waring is critical of the approach in BS 8800;

“There is a considerable gap between necessary systematic requirements, which the BS covers comprehensively and necessary and fully systematic and systemic requirements, which success demands.”

A further amplification of the implications of Waring’s human activity systems approach is given under Individual World Views of Safety Culture in Section 2.18.5.

2.16 Organisational Culture in a Wider Context

The concept of safety culture has already been introduced and discussed. The concept will now be reviewed in a wider context.

2.16.1 National Cultures

A study of organisational cultures in IBM installations in different countries, was conducted by Hofstede, (1991). Hofstede, referred to organisational culture as;

“The collective programming of the mind which distinguishes the members of one group or category of people from another.”

Hofstede concluded that there were four dimensions which could be used to illustrate national cultural differences. These were:

- *Power/distance – A measure of the power difference between boss and subordinate*
- *Individualist/collectivist – A measure of the power of the individual compared with the group*
- *Uncertainty avoidance – Degree to which ambiguity is tolerated*
- *Masculinity/femininity – Assertiveness compared with caring*

These definitions are oversimplified but it is clear from the studies, that different nationalities took different positions in relation to these values. Although this thesis relates to a study conducted in a single country, Hofstede’s results provide an insight into the relative strength of cultural attitudes in respect of these dimensions. They also

serve to emphasise the caution that should be exercised in extrapolating the results of organisational cultural studies, between national cultures.

In broad terms, one could conclude that the British disposition is relatively favourable towards individualism, fairly strongly masculine, tolerant of ambiguity and does not favour a large power difference between boss and subordinate. Hofstede suggested that organisational culture could be pictured as an “onion diagram” of concentric circles in which the most visible manifestations were represented by the outer layer and with the deeper and less obvious manifestations at the centre. In his terms the layers, from outer to inner were:

- *Symbols* - e.g. words, pictures, dress, buildings
- *Heroes* - e.g. persons who are prized
- *Rituals* - e.g. ceremonies, meetings, greetings
- *Values* - e.g. preferences for money or time off work

2.16.2 The Structure of Culture

Deal & Kennedy, (1982) describe factors that determine company culture in terms of:

- *Business environment* - The most important single factor; marketplace, technology, government, etc.
- *Values* - The basic concepts and beliefs at the heart of the organisation
- *Heroes* - Role models who personify the culture's values
- *Rites and rituals* - Routines of daily life expected of members
- *Cultural network* - The primary (but informal) means of communication in the company

Rousseau, (1988) suggests that culture can be considered as:

- *Artefacts* - observable e.g. logo
- *Patterns of behaviour* - observable actions
- *Behavioural norms* - can be inferred from observable behaviour
- *Values* - as expressed consciously by organisation members
- *Basic assumptions* - core values, which may not be articulated

Schein, (1985) suggests three levels:

- *Artefacts* - buildings, language, overt behaviour
- *Values* - beliefs by which members justify actions
- *Underlying assumptions* - unconscious assumptions determining views/actions

Waring, (1993) sees culture as having three layers of meaning:

- *Manifest - symbolic artefacts, language, stories, rituals, normative conduct*
- *Strategic - strategic beliefs*
- *Core - ideologies, values, assumptions*

Waring sees the above distinctions as relating to the content dimension, other dimensions being strength, pervasiveness, localisation and direction.

It is clear from all of the sources quoted above, that there is wide agreement that organisational culture is a layered phenomenon and the semantic differences indicate that there is no settled definition. However, all the sources quoted take the same general view of overt manifestations at a surface level and deep seated values, of which the holders may not even be consciously aware. It is the deep seated shared values and beliefs that comprises the true essence of the culture.

2.16.3 Types of Company Culture

Various researchers have classified company cultures into different types. Deal & Kennedy, (1982), identify four generic cultures:

- *Tough-guy, macho - police, advertising, movies, sports, venture capital*
- *Work hard/play hard - benign but hyperactive, computer companies, sales*
- *Bet your company - high risk/slow feedback, aircraft makers, oil companies*
- *Process - low risk/slow feedback, banks, utilities, insurance companies*

Handy, (1993), following Harrison, (unpublished paper), suggests that there are four main types of culture, power, role, task and person. A power culture would be typified by an organisation run by a strong entrepreneur, with power of decision concentrated at the centre, little bureaucracy and few rules. A role culture would be typified by a bureaucracy, procedurally driven, slow and unresponsive and suited to a stable environment. A task culture is project oriented, with a matrix management style and is adaptable in a changing environment. A person culture is one in which the group exists for the individual, such as barristers' chambers.

Handy, (ibid.) suggests that different types of persons will be more comfortable in some kinds of organisation than others. Someone with a low tolerance of ambiguity and high needs for security, will be better fitted to a role culture. An individualist will be more comfortable in either a power or a task culture and will have greater opportunity for developing individual skills and talents. It should be noted that a particular type of

organisation is likely to tend to recruit the type of person suited to that organisation. A role culture, in which jobs can be specified down to any level, could more easily accommodate low-calibre staff.

On the same theme, Maccoby, (1976) identified four different character types, in a study of 250 US corporate managers, which he referred to as:

- *The jungle fighter -needs power, domineering, ruthless*
- *The company man -loyalty to organisation, careerist, conservative*
- *The gamesman -risk taker, competitive, seeks glory*
- *The craftsman -individualist, exacting, not a team person*

It would appear that different types would be better fitted to different organisational cultures. This could be significant at the selection process but it would also be significant if an organisation were attempting to make a cultural change.

2.16.4 Cultures Related to Organisational Activity

Handy, (ibid.) postulates four different activity types in any organisation:

- *Steady state - routine activity, easily programmed*
- *Innovation - changing things e.g. R&D, planning etc.*
- *Crisis - the unplanned, breakdowns etc.*
- *Policy - guidance and direction*

He suggests that different cultures may therefore be appropriate to different parts of the organisation and that this means that there is a need for differentiation between departments but also integration of the departments in the organisational objectives. Such differences can lead to conflict and it may also mean that the culture of the dominant function becomes the dominant culture in the organisation, to the detriment of other departments.

Seven different types of organisations are put forward by Mintzberg, (1989):

- *The entrepreneurial*
- *The machine*
- *The professional*
- *The innovative*
- *The missionary*

These different types of organisations can coexist in any large organisation but to produce an efficient organisation they must be bound effectively together.

Interestingly, a study by the La Porte group, (La Porte & Consolini, 1989), of high reliability US organisations, including nuclear aircraft carriers, air traffic control and power generation, found that the structure of operation differed with the demand on the system. Three different operating modes, routine, high-tempo and emergency, were observed. The routine mode involved standard operating procedures and a hierarchical, rank dependent authority chain of command. The high-tempo mode was operated by the same individuals under more demanding circumstances and was characterised by authority being based on functional skills and expertise and with more horizontal communication channels and less dependence on vertical communication. It was observed that the operators moved from routine to high-tempo mode automatically and without formality in response to the workload of an operator and would return to routine mode when the activity level returned to normal. The emergency mode was a response to a well defined danger and was based on predetermined and rehearsed plans. Teams were regrouped in an appropriate manner to deal with the particular situation. In other words, the same group of people were switching between bureaucratic, professional and disaster response regimes in what was a multi-layered, nested authority system. In commenting on these findings, Reason, (1990), suggests that such adaptive structures should be built into high risk organisations rather than developing as a result of hazardous operating experience.

In summary, it seems clear that organisational cultures can be described as layered, with overt characteristics as outer visible manifestations and with deeper values, which are not necessarily visible or articulated. Different cultures suit different types of organisation and different personalities suit different cultures. Different cultures can coexist within a large organisation and different behaviour patterns and structures can even exist within the same work group. The nature of organisational culture will be a function of history, the external environment as well as the function of the nature and purpose of the organisation.

2.17 The Usefulness of the Culture Metaphor

Morgan, (1985) identifies four separate aspects of culture which he suggests are the strengths of the culture metaphor. In the first instance it directs attention to the symbolic significance of even the most rational aspects of organisational life. The formality of meetings, or even an empty meeting room, with straight lines of chairs, neatly set out

pencils and pads and glasses for water, all convey a powerful sense of order and an expectation of formality. Secondly, the culture metaphor goes beyond the organisational design and procedures and highlights the significance of language, norms, folklore and ceremonies that communicate ideologies, values and beliefs. The manager can therefore be more than a co-ordinator and designer of structures and job descriptions and can be an actor influencing the shaping and fostering of desirable patterns of meaning. Thirdly, it encourages a more subtle interpretation of the approach to leadership. Leadership can become the management of meaning, so that leaders can be effective without necessarily being at the forefront of the action but by shaping the general direction of events. Finally, it provides a means of better understanding the essential aspects of the process of successful organisational change. In effect Morgan emphasises the need to build the organisation around people rather than around techniques. Morgan, (ibid.) cautions that management gurus, using the culture metaphor, may assume that culture is a distinct entity with clearly defined attributes. This would be an unduly mechanistic view and it can be used to create an Orwellian world of corporate newspeak, where culture controls rather than expresses human character. The fact that such manipulation may well be accompanied by resistance, resentment and mistrust is likely to receive scant attention.

2.18 Organisational Socialisation

Cultural transmission is achieved by *organisational socialisation* (Buchanan & Huczynski, 1997). This is the mechanism by which new members absorb and adopt the values, attitudes and behaviours which are the norm in the organisation. A newcomer progresses from being an *outsider* to a *new person*, to a *low person* before becoming a fully fledged *role-holder*. The process involves selection interview, adoption of overt norms, training, membership of a peer group, assimilation and acceptance. Progression may depend on appraisal systems which provide a clear indication of the expectations of the organisation and the attitude of senior management in respect of promoting and censoring will reinforce messages about company expectations in respect of norms, delegation, dress and appropriate topics for discussion.

2.19 Changing a Safety Culture

Since this thesis is concerned with the relationship between safety culture and the forces which mould the culture, it is appropriate to review the factors and strategies which

have been identified as particularly relevant in moulding and changing organisational culture.

2.19.1 The ACSNI HFSG Approach to Culture Change (HSC, 1993)

HSC, (1993), provides a prompt list of questions, derived from all the factors which have been identified as indicators of a good safety culture. In summary, it is suggested that the questions should be posed to determine the present state of the organisation in relation to these factors and then to determine which factors merit the highest priority for change. Using a step-by-step approach, it is then necessary to decide on actions that may change those aspects and launch those actions. Finally a further assessment should be made and the process repeated, choosing new priorities or new actions, in the light of the results. The process is therefore a continuous one.

2.19.2 The Difficulties of Culture Change

Attempts to change company culture are often prompted by reorganisation but as pointed out by Booth, (1996), a company reorganisation may be implemented as a step function but culture change will take time. Moreover the aftermath of a reorganisation could be doubly dangerous: trust may be impaired and personnel may continue to behave in a manner consistent with the old organisation but inconsistent with the new.

The fact that changing a culture is difficult is noted by Wheatley & Parker, (1996), who point out that forces such as recession, privatisation and increased commercial imperatives in every field have forced organisations to reduce costs, improve efficiency and increase responsiveness through restructuring and rationalisation. Cultural change, particularly in the form of increased empowerment and team-based working, is often sought as part of such changes. They refer to a rash of literature in the 1980s which suggested that organisational culture could be changed by following prescriptive courses of action such as:

- *Reviewing business strategy*
- *Establishing and communicating a corporate vision*
- *Formulating a mission statement*
- *Setting up communication, education and training*

The fact that many attempts to change culture result in failure, is due to the failure to recognise the complexity of the phenomenon. According to Wheatley & Parker (ibid.), a

company culture probably encompasses several cultures, especially if it is large and dispersed. It overlaps with other cultures, such as the local community and those of other groups with which employees are connected. It encloses sub-cultures and counter cultures. It will, furthermore, be deeply enmeshed in self-reinforcing interactions between existing behaviours, values, attitudes and structures. It may be extremely distinctive, it will be resilient and it will effect people strongly even though they are hardly aware of its influence. According to Johnson, (1991), organisational cultures are notoriously difficult to change and there is no reason to suppose that a safety culture will be any different in this respect.

Buchanan & Huczynski, (1997) state that the longer a culture exists, the more entrenched it becomes because of its self-reinforcing nature. It is the very stability of the cultural elements that resist change. They identify four constraints to change:

1. Structural and technological obstacles are provided by documentation, procedures, buildings and formal structures. These factors make culture change impracticable in the short to medium term.
2. Employees may resist culture change which threatens familiar symbols, beliefs and values.
3. Managers themselves, including top management may resist a threat to their core values and power interests. Also, since culture embraces products, recruitment, reward systems and the whole of corporate life, its pervasiveness will ensure that much of it is implicit in peoples' behaviour and therefore difficult to change.
4. Constraints will arise from the societal and industrial context of the organisation. In other words the culture is a function of independent variables operating at the levels of society, industry and organisation.

If, as Schein, (1985) suggests, the culture of an organisation comprises the unconscious assumptions, taken for granted, at the deepest level of a multi-layered structure, then it is little wonder that so many researchers comment on the difficulty of effecting change. Indeed, it has been argued (Smircich, 1983), that culture may be regarded either as something an organisation *has*, or as something an organisation *is*. If culture is something that an organisation has, then according to Ogbonna, (1992), it becomes a powerful organisational tool. It shapes behaviour, gives organisational members a sense of identity and establishes recognised and accepted premises for decision making. On

the other hand, if culture is what an organisation is, then it can be argued that there is little point in trying to control something which is embedded in the roots of the organisation's existence. Ogbonna, (ibid.) argues that since culture is a social phenomenon, depending on social interaction, it has been learnt, reinforced and passed down. In other words it is an adaptive learning process and therefore it should be possible to change it.

The nature of the difficulty in achieving culture change is explained by Waring, (1996) by the fact that the organisational culture provides a daily reaffirmation and reinforcement, for its members, of their personal and professional identities (what it means to hold a particular job in that organisation). Therefore any proposal to alter the culture (or any of the organisational factors associated with it), is likely to encounter some resistance, depending on how big a threat to particular values, identities and interests is perceived. An example of this is provided by Golzen, (1987, cited in Mullins, 1996), who referred to IBM's unsuccessful attempt to modify its belief system to highlight the importance of being a low cost producer. This was resisted by employees because it was perceived to contradict its fundamental philosophy of being a quality conscious company. The extent to which the deep seated attitudes that people have come to espouse, govern their everyday behaviour, is indicated by Lee, (1993) who states that:

“unless people develop a structured set of attitudes and ways of perceiving things, they would not be able to react to the stream of events without constantly reassessing each single event that occurs.”

It is appropriate here, to refer to the difficulty which can arise when behaviour is in conflict with attitude. Festinger, (1957), developed the concept of cognitive dissonance, which assumes that people strive to make their attitudes and behaviour consistent and where this is not the case, stress will result (Glendon & McKenna 1995).

Another factor which should not be ignored (Turner et al., 1989), is the well founded resistance at the lower levels of any organisation, to the latest fads and fashions which are imposed from above, so that safety culture may be seen as something which only requires lip-service, until the current enthusiasm has been replaced by another.

Donald & Canter, (1993), point out that behaviour is based on peoples' views of what is expected of them. These expectations are based on their interpretation of the meaning of events, rules and instructions. Their interpretation of an executive statement that "safety is as important as production" will depend on what they believe the organisation really means and their subsequent behaviour will depend on that interpretation.

A further danger to which Turner et al., (ibid.) draw attention, is the need for companies to recognise the distinction between the managerial or corporate view, (which does not, in itself, constitute the safety culture) and the true "culture-in-work," which embodies assumptions and traditions which can only be understood in the context of wider sets of beliefs which offer a world view on matters of work and leisure, safety, danger and injury, life and death.

2.19.3 Culture Change in a State Bureaucracy

Bate, (1990) describes a three year organisation development project with British Rail, which involved an understanding of the culture of the organisation, with a view to improving the effectiveness of the organisation. (It may be argued that certain features of British Rail bore some similarity to the pre-privatisation Electricity Supply Industry in the sense that both were essentially bureaucratic, hierarchical, state owned, monopolies with rule-based procedures.) Bate describes the ever-present tensions between the different parts of the British Rail organisation and the attempts to achieve a true integration of effort. He describes three variant images of the organisation drawn up in participative sessions with the managers. The first is *Segmentalist*, in which the structure, culture, roles, processes, orientations and outcomes are all characterised by the self-interest of the contending parts of the organisation. (By common consent the senior managers accepted that this view characterised the existing state). The second variant is *Integrative*, in which the various aspects of the organisation are characterised by submission to central authoritarian direction. The final variant, was termed *Adaptive* and was characterised by a *partnership culture*, in which the relationships between the different parts of the organisation were determined by contracts, which were task-centred, of fixed duration and were explicit and understood. This was suggested by the managers themselves, in participative sessions, to be the desired variant. The method proposed for implementing the desired variant, was to involve the managers themselves

in working out the nature of the contracts. During this process various difficulties were identified and dealt with.

2.19.4 The Process of Culture Change

An elaborate model of the process of effecting culture change was proposed by Silverzweig & Allen, (1976), which is discussed by Ogbonna, (1992). The model comprises four stages in which organisation members are heavily involved. The first stage is to analyse the existing culture to establish the existing norms and the second is to establish the norms that organisation members would like the organisation to develop. The third stage is to install the system following involvement in workshops, during which great emphasis is placed on leadership and on managers acting as role models. The final stage is on-going evaluation and renewal. In all of the above process, important factors are leadership, influence of work-team cultures, information and communication systems, performance and reward systems, organisational policies and procedures, training and orientation, supervision and results orientation.

Considering first the issue of leadership, it is important that leaders are seen to be practising what they preach. In any attempt to introduce a step change in culture this is likely to introduce a problem for an existing leader, the credibility of whose beliefs may well be questioned by the workforce. Perhaps a culture change may be more successful under new leadership but this poses the question of the extent of change required in the leadership. In relation to the importance of work-team cultures, it is suggested that moves towards more flexible team structures may help to break down existing demarcations and help to develop stronger identification with the wider organisational values. The importance of information and communication systems cannot be overstated, although this would seem to carry the danger of accusations of manipulative management. Modification of performance and reward systems is seen as necessary to recognise the behaviours which are to be valued in the new culture. Policies and procedures must also be adjusted to ensure that they are consistent with the values the organisation is seeking to promote. Training and orientation must obviously be consistent with the values being promoted and the role of the supervisor is seen as particularly important. Finally, it is important that there are specific and measurable objectives so that progress can be measured and demonstrated, without which the commitment of those who are cynical is unlikely to be obtained.

2.19.5 Individual World Views of Safety Culture

Waring, (1996), states that an individual's view of safety culture will be influenced by his or her world view. This results in two broad views of safety culture; a *functionalist* view and an *interpretive* view. Those whose views of organisational culture are mechanistic and see it in terms described by Waring as “clockworks plus humans,” base their view of organisational culture on the following assumptions:

- *Organisational culture has a predetermined function*
- *Organisational structures epitomise the particular organisational culture*
- *The function of organisational culture is to support formal, rationally designed management systems and strategies*
- *Organisational culture can be reduced to relatively simple cause and effect models, i.e. a large degree of predictability and control*
- *Organisational cultures can be and should be manipulated to serve corporate, (i.e. managerial) interests*
- *There exists an ideal type of culture to which organisations should aspire*
- *There exist ideal or appropriate ways in which to manipulate organisational culture for the purpose of managerial prediction and control*

The idea that corporate culture can be used as a tool of management control has promoted interest in how it can be created, institutionalised and changed and has led to the notion of a *culture gap*, the difference between the kind of culture that the company currently possesses and the kind that its senior management would like it to have (Buchanan & Huczynski, 1997)

Waring, (ibid.) identifies a number of difficulties arising from the functionalist view. Functionalists fail to recognise the distinction between the values and change strategies proclaimed by management and the enacted values in the organisation as a whole. They also expect that the problems of the organisation can be solved by formal engineering of cultural change by management. (i.e. the workforce are like programmable robots). They further believe that culture change will be achieved, by decree or prescription, relatively quickly, typically within three years.

According to Waring, an interpretive view is that organisations are human activity systems and are characterised by the following assumptions:

- *Culture is regarded as an emergent phenomenon of social groupings*
- *Organisations may be regarded as multicultural assemblages having characteristic discourses within and between them*
- *Organisational culture is a means for the organisation's members to interpret their own existence, identity and actions and to institute, guide and moderate those actions*
- *Organisational culture is regarded as complex and incapable of reduction to a simple cause-effect model*
- *Organisational structures, systems, strategies, processes and cultures reflect each other*
- *Formal structures, systems, strategies and processes support the prevailing organisational culture*
- *"Ownership" of organisational culture is not the sole prerogative of senior management*
- *Pursuit of an ideal type of organisation culture begs the question, "whose ideal?"; each organisation's culture is a unique creation of all its members*
- *Managerial attempts to manipulate organisational culture to achieve rapid organisational change are likely to fail*

Professionals who tend to use reduced models and quantification in their thinking, are particularly prone to a functionalist view. This is true of engineers and Mangham, (1979) notes that engineers tend to use engineering ideas, assumptions and models in relation to problems, including people and management problems. This means that engineers (as well as other professionals who are used to a mechanistic approach), will probably tend towards a prescriptive, top-down, mission statement type of approach and will be looking for rapid results. It was also noted by Clark, (1997), that engineers and managers involved in interactive safety training, who were used to dealing with practical problems, tended to avoid behavioural issues and concentrate on technical matters with which they were more comfortable. Commenting on the response of the OECD Nuclear Energy Agency (1987:9) to the implications of Chernobyl, Turner et al., (1989), make a powerful case for the "impoverished" engineering/technical managerial view of the socio-technological system. They point out that the notion of safety culture is reduced, on the one hand, to sets of administrative procedures for training, emergency plans etc, and on the other, to *individual* attitudes to safety and danger which, it is thought, "cannot be regulated." There is no indication of the crucial importance which

shared attitudes and beliefs might play in determining how employees, in an industrial setting, come to consider matters of safety precautions and the enforcement of rules, along with other aspects of their working life.

Waring points out that chief executives' values, pronouncements and actions do make a vital lead contribution to safety culture but they cannot determine culture in the way they can set policy, plans and allocate resources. In support of this view Toft, (1992) argues that attempts to change safety cultures by management edict or prescription, will meet with only limited success. Toft suggests that permanent change is best achieved through a long term "organisational learning" approach. This may be achieved by the organisation responding to an accident or by crisis simulation exercises.

2.19.6 Factors Influencing Rate of Culture Change and Propensity to Change

Williams et al., (1989), propose a number of factors which are likely to predispose an organisation towards stability or change. These are set out in Table 2.1.

Williams et al., (ibid.), also propose a force field model (see Table 2.2), relating to the propensity of an organisation to change, which is based on the work of Lewin, (1951). The model depicts the driving forces and the restraining forces so that the relative strengths of these forces can be assessed, depending on the nature of the change in prospect. The model can be used to identify the strategies that may be required to modify the force field in order to promote change. It is pointed out that if the model is used in this way, by an organisation wishing to promote change, there is a danger that too much concentration on the driving forces at the expense of the restraining forces, will result in undue stress on the system, with consequences such as resistance to change and poor morale.

It is suggested that the likelihood that an organisation will embrace change, will be a function of the relative strength of the various forces favouring change or restraint, taking into account the relative importance (i.e. weighting) of these forces in a given organisation and a given situation.

Table 2.1

Factors Favouring Change	Factors Favouring Stability
Openness to new ideas	Internally focused on rules and procedures
Customer surveys	
Monitors competitor activity and performance	Criteria of success unclear
Monitors own performance	
Uses external consultants	Internal training, internally validated
External training and management education	
Uncertain and volatile market	Predictable and stable market
Competitive market	Dominant in market
	Powerful political lobby
Crisis	Success
Crisis seen as a challenge	Feelings of insecurity and threat
Authority can be challenged	Strict regard for authority and status
New ideas, innovation and risk-taking valued	
Senior management brought in when required	Home-grown management
Multiple-level entry into organisation	Career based, jobs for life
	Single-level entry into organisation
Powerful external stakeholders	Ultimate authority unclear
Non-executive directors from outside industry	Board all from within company or industry
	Low turnover, cohesive work groups and strong conformity pressures
Selection procedures objectively validated on regular basis	Selection based on ad hoc interviews, or traditional selection and recruitment procedures which are not validated, or validated against subjective, internal criteria

Table 2.2

Forces Driving Change	Forces Restraining Change
Change at the top	Career based organisation
Powerful external forces	Low turnover
Vision of the future	Success
Powerful leader	Stable environment
Acceptance of need to change	Criteria of success not visible
Externally focused	Lack of clear authority
Crisis or opportunity	

2.20 Measurement of Safety Culture

Many different approaches have been used to attempt to measure safety climate or safety culture. Ostrom et al., (1993), have described an instrument for surveying organisational safety culture. After having first identified “desirable safety norms”, they arrived at 84 statements which were put into a questionnaire in the form of a 5-point Likert scale. The authors suggest that the responses, once analysed, provide pointers to weaknesses upon which attention can be focused.

A safety survey at Sellafield is described by Lee, (1993), in which safety concerns were first identified using employee focus groups and the data obtained were used to construct a questionnaire consisting of 172 attitude statements embracing 9 general areas of safety. Employees were asked to respond on the basis of a 7-point Likert scale. The results were analysed using principal components analysis, which identified a total of 19 factors across the 9 areas relevant to safety. Respondents’ anonymity was preserved but they were asked to indicate certain factors about themselves, such as age, sex and if they had experienced an accident. Lee was able to identify certain personal attitudes and attributes as predictors of accident experience but also demonstrated that

such a survey can identify weaknesses in the organisational arrangements which can be addressed, such as lack of management visibility on the shop floor.

The approach of Donald & Canter, (1993), was to develop a safety attitude questionnaire which was refined so that the responses to some 30 questions was sufficient to map attitudes and perceptions and thereby identify the need for change in management practices or processes. They have used this technique to identify differences between different departments within the same organisation. Canter & Donald, (1990), also provide evidence that the very process of research into safety culture, during the administering of questionnaires, can result in the Hawthorne effect, in which the researchers presence changes the social processes. Rather than regard this as a weakness, they see the management of safety as a context in which the Hawthorne effect could save lives. Donald, (1997), describes in some detail, the intervention process which has been used, following an attitude survey and analysis of the results, to effect an improvement in a structured way by harnessing worker involvement and management commitment and using action plans backed by resources.

An account of the use of a safety climate measure is given by Budworth, (1997), which is based on a questionnaire containing 30 statements using a 5-point Likert scale. The results of the survey are once again used to identify areas of weakness for management attention. A triangulation technique is proposed by Cox et al., (1997), in which three complementary methods are employed. The techniques used are questionnaires, interviews and focus groups and direct and indirect observation. The combination is referred to as a safety climate measurement tool kit.

The HSE have also developed a tool to use to assess aspects of an organisation's health and safety climate (Byrom & Corbridge, 1997), comprising a 71 statement employee questionnaire, guidance booklet and computer software. The approach is based on the HSE's document HS(G)65, Successful Health and Safety Management. The respondents are asked to rate the statements in the questionnaire on the basis of a 5-point Likert scale. The responses are obtained separately from the workforce, supervisors and management. The software enables the organisation to customise the questionnaire and to analyse the results. It is claimed that the system has proved useful

for bench-marking, providing baselines, monitoring and generally complementing audits.

A further triangulation measure has been developed by Dalling, (1997), based on a safety performance model, which is relevant not only to safety but to other aspects of management including quality, security and the environment. Dalling identifies six critical interacting components in the model as culture, the management system, the knowledge base, corporate leadership, group or individual consciousness and stakeholders. Dalling emphasises that attitudes, perceptions, beliefs and values will be very slow to change, especially with low staff turnover but points out that “contractorisation” can introduce new safety cultural elements into the safety climate. The technique is based on a safety culture framework comprising three main elements, management and organisational factors, enabling activities and individual factors. Data is gathered on these three elements, using management interviews, check lists and individual questionnaires respectively, in order to assess the safety culture. The technique has been used in several industries and has proved useful in identifying actions for improvement.

Chapter 3

ORGANISATIONAL OVERVIEW

Particulars are not to be examined till the whole has been surveyed.

Dr Samuel Johnson

1709-1784

3.1 Introduction

An important part of the research was to undertake an historical review of the events preceding the period of direct observation and data collection. The purpose was to analyse and understand the nature of the industry and organisation in which the changes were to take place. It was deemed to be essential to obtain an appreciation of the values, attitudes and beliefs which characterised the original organisation. The purpose of this Chapter is to provide a brief organisational overview of the industry, an overview of the privatisation process and to set PSB in the context of the ESI.

3.2 The Structure of the Electricity Supply Industry

In order to understand the complex forces which have moulded and influenced the safety culture of the pumped storage generating business in North Wales, it is necessary to have some understanding of the evolving structure of the Electricity Supply Industry in England and Wales and the position of the business within that Industry. The Electricity Supply Industry was privatised in 1990. Prior to that time the Central Electricity Generating Board (CEGB) was responsible for the generation of electricity at power stations throughout England and Wales and for high voltage transmission, via the grid network, to twelve Area Electricity Boards, each covering a geographical area of England and Wales. The effect of privatisation was to convert the twelve Area Electricity Boards into twelve equivalent Regional Electricity Companies (RECs), each covering the same geographical area as before and responsible for the distribution of electricity to customers in their respective areas. The Central Electricity Generating Board was split into three new generating companies and one transmission company.

The power stations of the CEGB were divided between the new generating companies (GENCOs). All the nuclear stations were allocated to Nuclear Electric, a large proportion of the remaining stations to National Power and the rest were allocated to PowerGen. There were two exceptions to this allocation. Two power stations in North Wales, which operated on the pumped storage principle, were allocated to the transmission company, National Grid Company (NGC). NGC was charged with the responsibility for operating the high voltage transmission network throughout England and Wales, taking electrical energy from the GENCOs at the various points of generation and transmitting the energy to the RECs at their various bulk supply points. In addition, NGC operated the two pumped storage stations as a generating business also feeding into the grid network.

In 1995, NGC's pumped storage business was de-merged from the rest of NGC and was re-named First Hydro. In December 1995, First Hydro was sold to Edison Mission Energy, a subsidiary of a United States utility company.

3.3 The Market For Electricity

One of the objectives of privatisation was to introduce competition into the production of electricity and to further this process by encouraging the establishment of additional generating companies. The privatisation legislation introduced a spot market for electricity also known as the "Pool". The GENCOs sell electricity into the Pool and the RECs buy electricity in the Pool which they then sell to their customers. The Pool is operated by NGC. Not only do NGC have a central role in operating a safe and secure transmission network they are also responsible for operating the Pool system and for ensuring that it provides fair competition between generators. As well as the large generating companies formed from the CEGB, a number of new generating companies have been established since 1990 (new entrants) which now supply electricity direct to the grid network.

The legislation that established the privatised Electricity Industry is The Electricity Act 1989. All operators must be Licensed under that Act in order to be connected to Grid System. They may have either a Generation or Distribution Licence whilst NGC itself has a Transmission Licence. NGC is required to provide access to its transmission system without discrimination between existing and potential users.

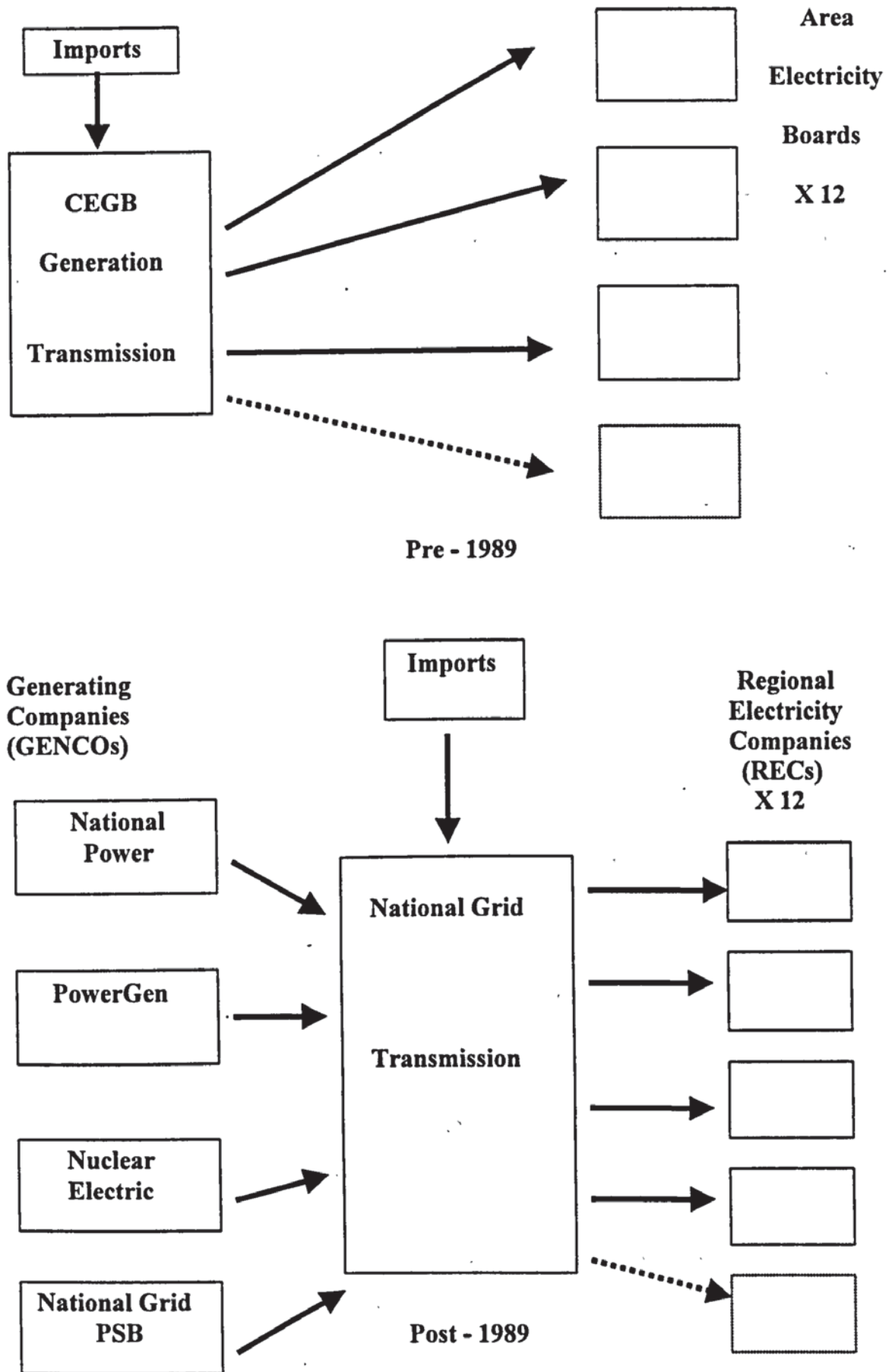


Figure 1: Simplified Representation of the ESI, Before and After Privatisation

The diagrams in Figure 1 illustrate the overall structure of the Electricity Supply Industry before and after privatisation.

3.4 The Operation of The Pool

Once electricity has been fed into the Grid it is no longer possible to identify its source. Nor is it possible to determine which generator is supplying electricity to any particular distributor at any one time. Generation is therefore in this sense "pooled".

Every morning, no later than 10 am, each generating company must inform the Pool of a number of key factors concerning its operation on the following day. It must provide the "offer price" for each of its generating sets, the availability of plant for each half hour of the day, the price at which it is willing to keep each set on standby, the state of readiness of the set and the price at which it is willing to operate, for a limited period, at a higher level of output than the declared availability. The Pool is then able to create a merit order, ranking each generating set in order of price and by examining its demand forecast it can calculate the operating regime best suited to efficient and economic matching of supply and demand. The Pool then publishes a schedule at 3 p.m. which notifies the generating companies of what generation it anticipates from them on the following day.

The price that is ultimately paid to generators is known as the Pool Purchase Price (PPP). This is made up as follows:

The System Marginal Price (SMP) is first calculated. This is the price of the most expensive generator in each half hour based on ideal conditions (if forecast demand equalled actual demand and there were no transmission constraints). To the SMP is added a capacity element made up of two further values - Loss of Load Probability (LOLP) and Value of Load Lost (VLL). LOLP is a statistical probability reflecting the possibility of available generation falling short of demand in any half hour period. VLL is a notional market value of the amount a customer would be prepared to pay for the last unit of electricity on the system. A value of £2,000 per MWh was set upon the formation of the Pool in 1990 and it has been index-linked ever since.

$$PPP = SMP + LOLP (VLL - SMP)$$

Suppliers must pay Pool Selling Price (PSP) for the energy they receive. PSP is a combination of PPP plus a number of other costs collectively known as uplift. This is

made up of costs resulting from the difference between forecast and actual demand; costs due to holding generators on or off as a result of transmission constraints; costs due to generators re-declaring their availability; payments made to generators for being available even if they did not generate and payments for ancillary services such as reserve and frequency control. The final Pool Selling Price is calculated 17 working days after each trading day based on metering information which is collected every second of the day at generation and supply points.

3.5 The Pumped Storage Principle

The principle of operation of a pumped storage system is that it relies on an upper and a lower reservoir. The power station uses water from the upper reservoir to generate electricity during the day when the demand is relatively high and uses electricity to pump water back up from the lower reservoir to the upper reservoir when demand is low, typically at night. Since the creation of the spot market for electricity in the Pool, the Pool price generally follows demand, moderated by factors such as plant availability on the system and the marketing strategies of the other generators. It must therefore be appreciated that the pumped storage business is not only involved in selling electricity but is also a major purchaser of electricity from the Pool.

An advantage of pumped storage plant is its very rapid response time which means that it is extremely useful as reserve capacity for coping with sudden increases in demand on the National Grid network or sudden shortfalls of supply caused by plant failures elsewhere on the system.

3.6 Pumped Storage as a Business

During the data collection period of this research, the pumped storage business was initially owned by NGC and was then known as the Pumped Storage Business (PSB). It was then de-merged from NGC and was owned, for a short time directly by the RECs. It was then known as First Hydro (FH). It was then sold to Edison Mission Energy, retaining the name of First Hydro and operating as an independent subsidiary company. Throughout all that time, whether operating as part of NGC or as an independent company, it was a competitive generator in the electricity market in England and Wales.

When it was part of NGC it should be noted that the activities of PSB were distinctly different from the rest of NGC which was concerned with transmission and related support activities. The transmission activities of NGC are a regulated monopoly and subject to a price cap but PSB is selling electricity into the Pool and is therefore free of such regulation. Since NGC operates the Pool system and is obliged to operate fairly and without discrimination between GENCOs it was clearly necessary for NGC to maintain confidentiality between PSB and the rest of NGC. This required "Chinese walls" between certain aspects of NGC's operations and the PSB thus reinforcing the separate identity of PSB within NGC.

3.7 The Pumped Storage Business Sites

3.7.1 Ffestiniog

Ffestiniog Power Station is situated at Blaneau Ffestiniog and was commissioned in 1963. It has four 90 MW units which can reach full output from spinning in air in 60 seconds. Ffestiniog has a capacity, which is governed by water storage capacity, of three hours at full load. The upper (Stwlan) reservoir is 305m above the power station and was formed by enlarging a natural lake. The lower (Tan-y-Grisian) reservoir was formed by damming the Afon Ystradan.

The power station occupies a building adjacent to the bottom reservoir. The generating plant, control room, workshops, administrative accommodation and other facilities are all located within this building. Approximately one third of the power station is visible above ground. The pumps, turbines and alternators are below ground level. Each pump and turbine is connected to a common shaft but the pumps are only engaged, via gearing, when the station is in pumping mode. When the station is pumping water to the top reservoir, the turbine inlet valve is closed and the alternator acts as a motor, taking energy from the Grid and driving the pump. The top reservoir provides two million cubic metres of water storage and the water level cycles some 5.4m during daily operation. The output voltage of 16kV is stepped up to 275kV by transformers and is connected by two overhead line circuits to Trawsfynedd substation. Ffestiniog operates a five shift system and at the start of the data collection period, (June 1994), a total of 46 shift and day staff were employed on site. A cross-sectional view of the Ffestiniog facility is illustrated in Figure 2.



Figure 2: Cross-section of Ffestiniog Scheme

3.7.2 *Dinorwig*

Dinorwig is situated at Llanberis and was commissioned in 1984. It is the largest pumped storage station in Europe and is still regarded as being at the leading edge of technology in terms of speed of response. Dinorwig was the first power station in the world to be designed to be able to deliver its full output (c1800MW) i.e. zero to full load, in 10 seconds. This speed of response enables the station to compensate for a sudden loss of generating capacity elsewhere on the system, or a sudden large increase in demand. It thereby reduces the amount of expensive thermal capacity on synchronised standby. In addition, the speed of response is extremely useful for NGC's National Control Centre, in their efforts to maintain system frequency within statutory limits at times of rapidly fluctuating supply and demand.

The station was built on the site of one of the two largest slate quarries in the world and was a working quarry until 1969. The lower reservoir is Llyn Peris from which a considerable amount of quarry waste was removed when the station was built, thus restoring the natural lake to its original size. The upper reservoir, Marchlyn Mawr, was created by enlarging an existing lake. A full generating cycle uses a maximum of 6.7 million cubic metres of water and involves a rise and fall in water level of some 33m. There are six pump/turbine motor/alternator sets. Each is reversible and operates at 500rpm in either direction, depending on whether the station is in the turbine/alternator or pump/motor mode. The water supply to each turbine is controlled by a 2.5m diameter main inlet valve (MIV).

As may be seen from Figure 3, water flows from the upper reservoir, through the low pressure tunnel, to the vertical surge shaft and from the base of the surge shaft, down a high pressure tunnel. It then flows into a manifold from which six high pressure penstocks each lead to an MIV and thence into a turbine. The water flows out of the turbines via tailrace tunnels, to the lower lake, the surface of which is above the level of the station. The effective minimum head of water is therefore 443m. Since there is only one LP tunnel, surge shaft and HP tunnel, any work which requires access to these parts of the plant, necessitates a station shut-down and de-watering is necessary if human access is required. The station generates at 18kV and the output is stepped up by transformers to 400kV. There is a 400kV switching station located in an underground



Figure 3: Cross-section of Dinorwig Scheme

cavern, from which two 400kV cables connect the power station to the Grid at Pentir substation, 6km from the site.

Workshops, offices, control room and stores are all located underground inside the mountain in a network of caverns, tunnels and galleries. The administration offices, canteen and certain other facilities, are located in a building outside the mountain, adjacent to the bottom lake. The operations staff work to a five shift system and they, as well as the day maintenance staff and some of the technical staff, are located underground. The administrative, management and some of the technical staff, are located in the administration block. At the beginning of data collection (June 1994), a total of 129 staff were employed at Dinorwig.

3.7.3 Bala House

Bala House is the administrative headquarters of the Business and is located on a modern business park outside Chester just inside the Welsh border.

At the start of data collection the General Manager, the Commercial Manager and the Business Development Manager together with some support staff were located there, numbering seventeen staff in all.

Chapter 4

THE EVOLUTION OF THE PUMPED STORAGE BUSINESS

We will now discuss in a little more detail the struggle for existence.

Charles Darwin 1809-1882

4.1 Introduction

This Chapter provides more detailed background information relating to the evolution of PSB, within the context of its parent organisation, NGC. The nature of PSB's business and the organisational structure of PSB is described.

4.2 Overview

Ffestiniog power station was commissioned in 1963 by the CEGB and became the major station within the North Wales Hydro-Group. The other satellite stations were Maentwrog, Rhiedol, Dolgarrog and Cym Dyli. Ffestiniog remained the lead station within this group until the formation of the National Grid Division of the CEGB in the lead up to privatisation in 1989. In this process the satellite stations were allocated to various other CEGB successor companies. From the time it was commissioned, in 1984, Dinorwig was under separate management within the CEGB, until the formation of the National Grid Division of the CEGB, prior to privatisation in 1989.

At privatisation the Pumped Storage Business was established within NGC with the two power stations under the control of a newly appointed General Manager Pumped Storage. He was initially located at Dinorwig although he spent much of his time, in the early days, at NGC Headquarters at Bankside House, London. Bala House was acquired as an administrative headquarters in 1990. The General Manager was relocated there and other staff were then recruited to Bala House. From that time, the Pumped Storage Business took essentially the form which it retained during its ownership by NGC and in which it became First Hydro. PSB was therefore formed as a business organisation by NGC as part of NGC's own evolving organisational structure. To understand the PSB

organisation in context, it is therefore appropriate to have an appreciation of the structural evolution of NGC.

4.3 The Ownership and Control of the National Grid Company

At the time of privatisation, each of the electricity companies, with the exception of NGC, became a PLC, quoted on the Stock Market. NGC was wholly owned by the 12 RECs in proportions determined at privatisation. NGC therefore formed part of the assets of each of the RECs and any profit made by NGC formed part of the profits of the RECs. (In fact, due to the relative size of NGC compared with any of the RECs, NGC contributed approximately 50% of REC profits.)

The ownership of NGC was exercised by The National Grid Holding Company, the Board of which comprised one representative of each of the RECs. The government retained a "special share" in both the Holding Company and in NGC. One of the key functions of the Holding Company was to approve the medium term business plan of NGC, which had to include a policy for determining dividend payments to the shareholders of NGC, the RECs. The operational activities of NGC had to be at "arm's length" from the Holding Company and NGC was therefore run on a day to day basis by The National Grid Operating Company. The Holding Company could not withhold consent on proposals concerning NGC's main transmission business unless the financial viability of NGC was threatened. The Board of NGC in 1994, comprised a Chairman, Chief Executive, three group executive directors and four non-executive directors. The Chairman and the Chief Executive of NGC were entitled to receive notice of meetings of the Holding Company and one or other of them was entitled to attend and speak but not to vote at such meetings.

During the period of data collection (June 1994-February 97), the flotation of NGC on the Stock Market was under active consideration by the owners, the RECs. The most likely time for the flotation was originally considered to be May 1995. This would clearly have far reaching implications for NGC and was the most dominant issue occupying senior management of NGC at that time.

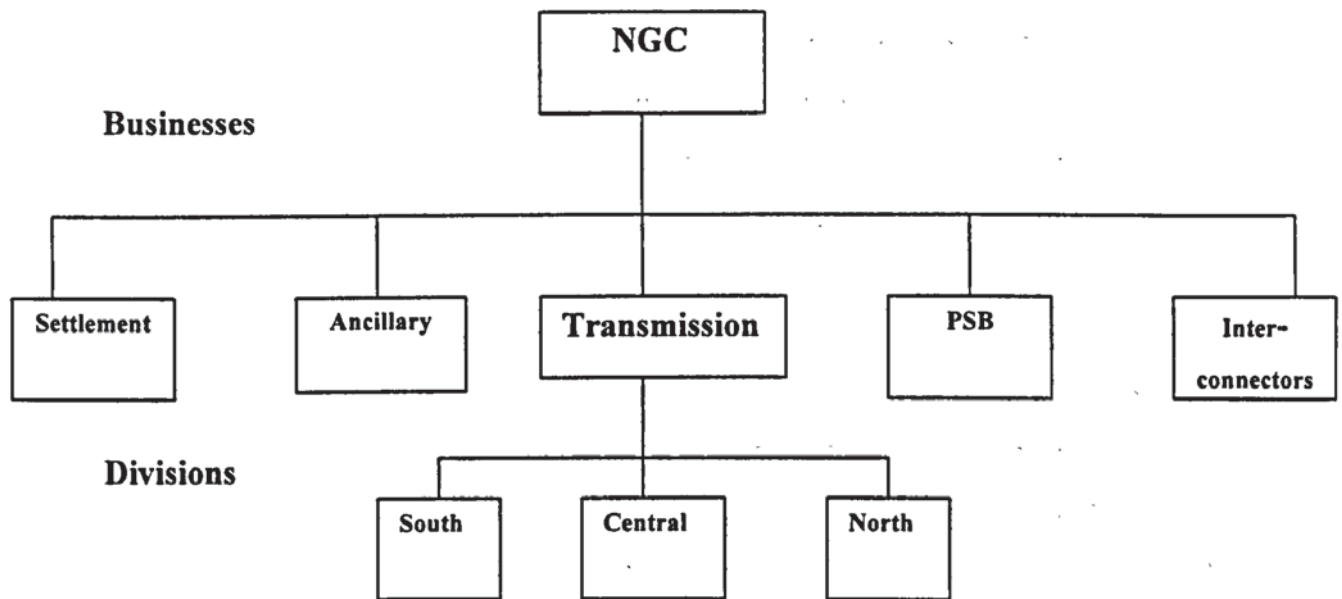


Figure 4a: Simplified Organisational Structure of NGC Until Restructuring

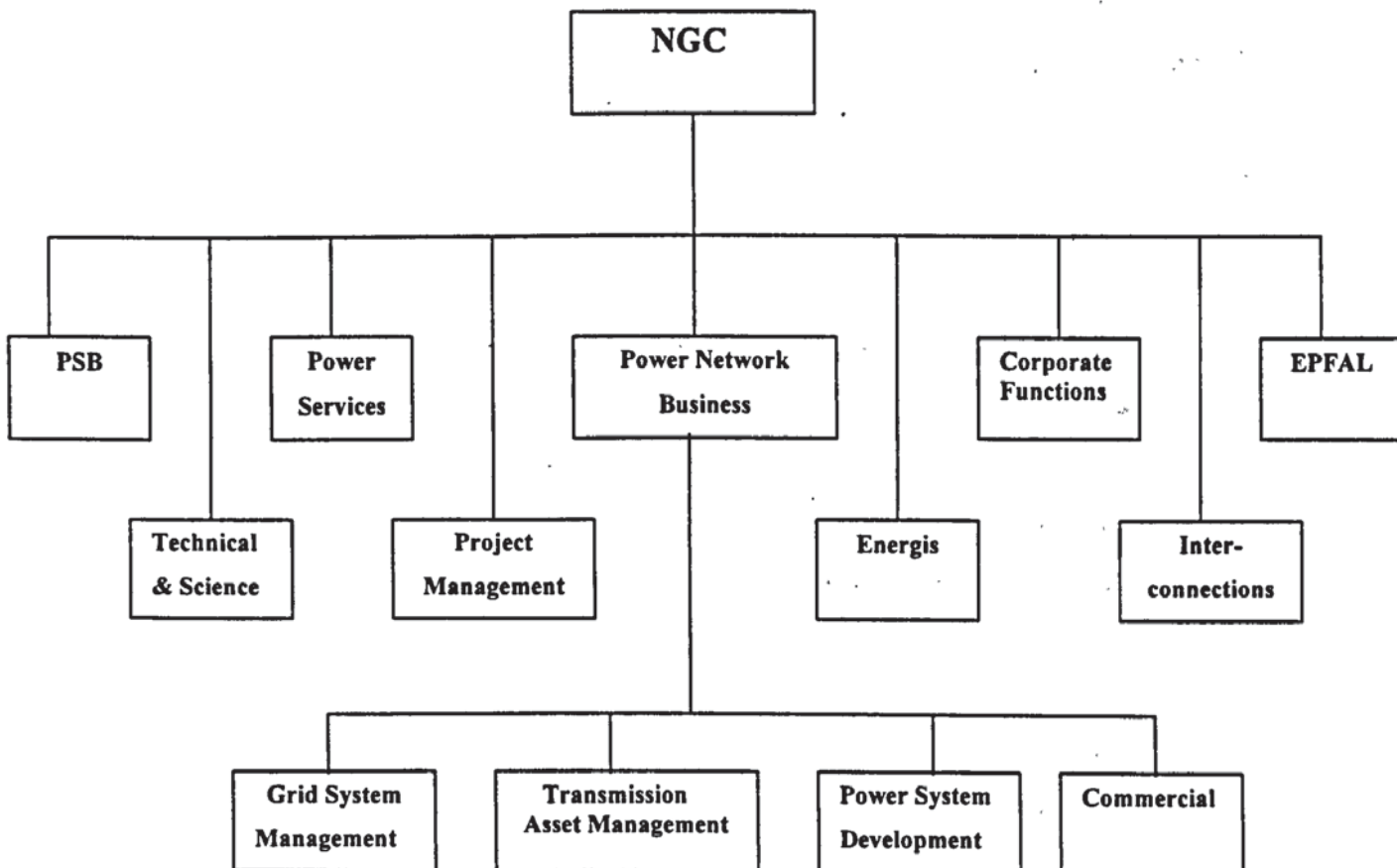


Figure 4b: Simplified Organisational Structure of NGC Post-Restructuring

4.4 The Structure of the National Grid Company

Since privatisation and up to the time of the de-merger of PSB, the organisational structure of NGC had undergone a number of major transformations. The comments in this chapter are based on the period up to the de-merger. NGC was by then organised in discrete business streams, each with its own profit and loss account. The evolving structure of NGC is depicted in Figure 4a, which illustrates the organisational structure at 1989/90 and in Figure 4b at 1993/94.

The “core business” of NGC is transmission, which accounts for by far the greater part of NGC’s income as well as the largest single group of staff. Since transmission clearly is a monopoly within England and Wales, it is regulated by the Office of Electricity Regulation (OFFER). The effect of this, is that the bulk of NGC’s income is subject to a price cap determined by OFFER.

The physical assets of NGC’s transmission system are owned and managed by the Power Network Business (PNB). PNB is responsible for the day-to-day control and co-ordination of the system, developing the system in response to customers needs and the setting and recovery of charges for use of the system. The Business is split into five distinct sections: Grid System Management, Transmission Asset Management, Power System Development, a Commercial section and a Financial section.

The Power Services Division of NGC (PSD), provides site operation and maintenance services to PNB as well as to other internal and external customers. In this respect PSD is effectively a contractor providing both internal and external services.

The Project Management Division is responsible for the design and the project management of the construction of high voltage transmission projects for both internal and external customers.

The Technology and Science Division develops and manages NGC’s technology strategy and long term research for the transmission system. The Interconnections Business operates NGC’s transmission links with France and with Scotland. Settlements is a wholly owned subsidiary of NGC and operates and administers the Electricity Pool system. The Energy Pool Funds Administration Ltd (EPFAL) provides a funds transfer service to the Pool. ENERGIS is another wholly owned subsidiary of NGC. It is a

business which has been established to exploit the telecommunications opportunities of a fibre-optic network installed on the earthwire of the transmission system. Business Development has the responsibility for seeking new business opportunities in the UK and internationally. The Information services Group provides IT services and support for the Company. The Pumped Storage Business runs two pumped storage power stations in North Wales – Dinorwig with an output of 1,729 MW and Ffestiniog with an output of 360 MW.

Most of the remaining Headquarters based Departments; Finance, Internal Audit, Secretary's Department have self-explanatory functions. The Group Resourcing Department provides human resource, health and safety and procurement services. It is a feature of the NGC organisation that the Headquarters functions provide services both to the Businesses and to the Executive. These services are provided against service level agreements which are internal contracts, specifying the nature and quality of the service, the price to be paid for the service and the amount of the service in both man-days and financial terms.

4.5 Pumped Storage as a Business

The Pumped Storage Business has three separate sources of income:

- *Energy sales* - In the same way as any other generator, PSB sells energy and capacity to the Pool by bidding in a price and availability for each of its ten generating units on a daily basis.
- *Ancillary services* - The second source of income is in the provision of ancillary services. Because of the rapid response characteristics of the plant, PSB has a contract with NGC's Ancillary Services to provide reserve capacity and frequency response to assist in maintaining both the stability of the system and an economic operating regime.
- *Contracts for differences* - The final main source of income is in what is known as "Contracts for Differences". Regional Electricity Companies have an obligation to publish fixed tariffs and therefore too much volatility in Pool prices gives them cause for concern. They hedge against the possibility of very high Pool prices by taking out Contracts for Differences with GENCOs. These are purely financial transactions in which, in return for a premium payment, Generators undertake to pay RECs the

amount by which the Pool price exceeds an agreed figure. Generators in turn, hedge against the possibility of having to pay, by bidding to the Pool a price which should ensure that they are called upon to generate and therefore receive payment from the Pool, at such times.

PSB receives approximately one third of its income from each of the three sources referred to above. As well as obtaining a large proportion of its income by selling electricity into the Pool, PSB is a major purchaser of electricity from the Pool, for pumping purposes. In fact, by virtue of its pumping demand, PSB can effectively set the night-time Pool Selling Price. The night-time demand of PSB can be greater than the demand of a number of RECs. The largest single cost of PSB is for the purchase of electricity. The other significant PSB costs in descending order are:

- Use of System Charges

- Rates

- Staff salary costs

- Maintenance

- Depreciation

4.6 PSB Management Objectives

The PSB mission statement reads:

“PSB aims to be the most dynamic generator of electricity, totally responsive to customer needs.”

The maximisation of profit, consistent with meeting its other obligations, is clearly a prime objective of PSB. Up to the time of de-merger PSB was however prevented from expanding its generating interests within England and Wales by the licence conditions imposed on NGC. Nevertheless the consolidation of the Pumped Storage Business as a generator within the new market environment was essentially complete. In order to increase the profitability of the Business the management thrust was therefore to improve the efficiency and productivity of the existing business as well as seeking new business development opportunities overseas. Both of these routes were being taken.

In order to increase efficiency and productivity, strenuous efforts were being made to improve availability and optimise the technical efficiency of the plant and to reduce costs with considerable emphasis on reductions in headcount. In the pursuit of overseas business, development opportunities were being sought, involving hydropower

schemes, in countries including India, France, Spain, and Ireland, thereby exploiting the strengths inherent within the business, which were considered to be excellence in the specification, operation, maintenance, marketing and management of hydropower assets.

4.7 The Organisation of PSB within NGC

4.7.1 Management Structure

The Pumped Storage Business was headed by a General Manager (Nigel Petrie) who, until de-merger, reported directly to the NGC Executive Director for Engineering, (EW Chefneux). The General Manager operated the Business with a four-man executive team i.e. Plant Manager, Engineering Development Manager, Commercial Manager and Business Development Manager. The division of the main functional responsibilities is illustrated in Fig 5.

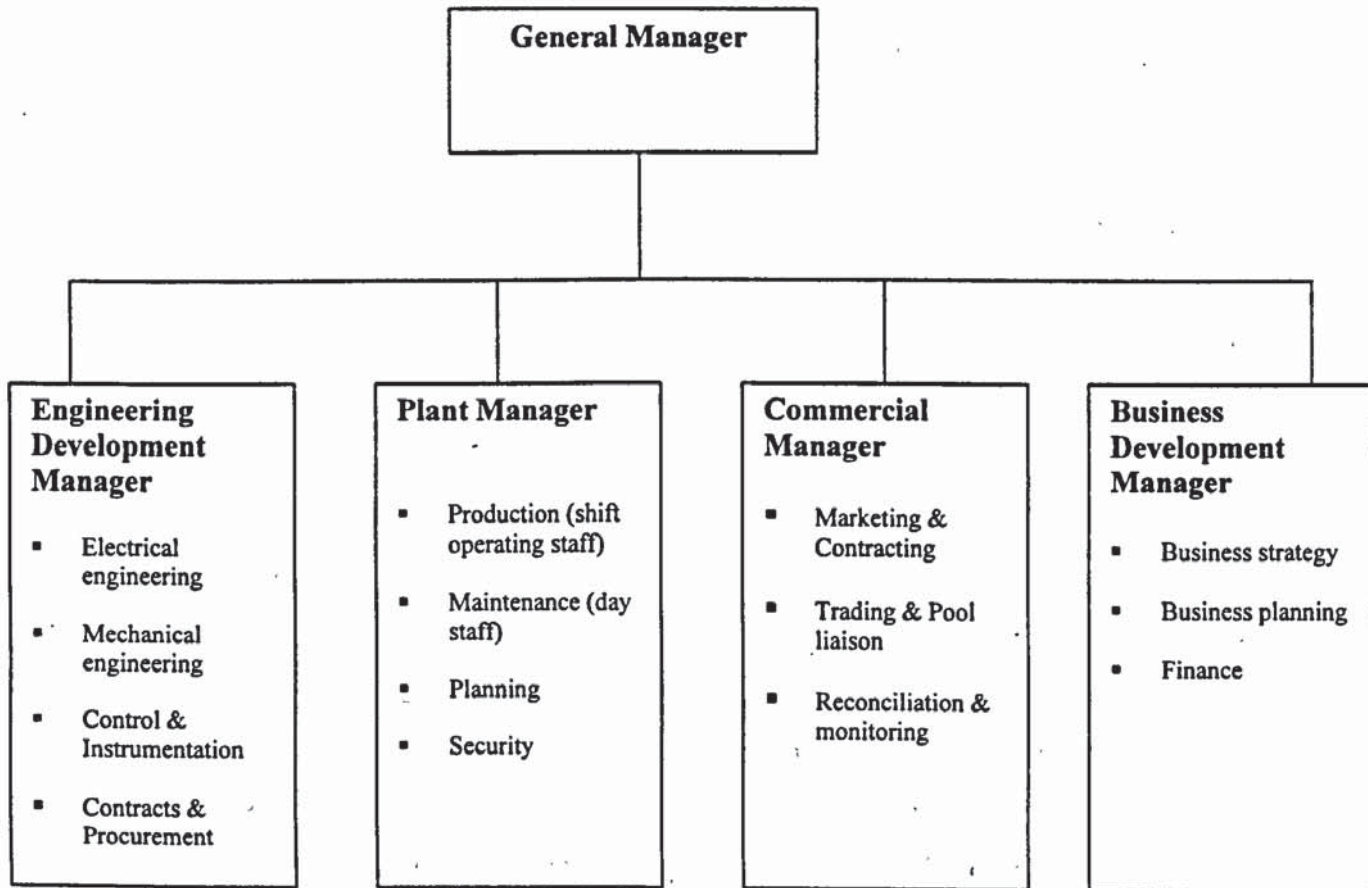


Figure 5: PSB Executive Team & Main Functional Responsibilities

The Commercial Manager and the Business Development Manager were located at Bala House whilst the Plant Manager and the Engineering Development Manager were both located at Dinorwig. The responsibilities of all of the above direct reports extended across the whole business. For example, the Plant Manager, although located at Dinorwig, was also responsible for Ffestiniog.

The main management forum was the PSB Management Executive comprising the General Manager and the Executive team which met monthly. The same group with the addition of the NGC Executive Director for Engineering and the NGC Group General Manager for Finance met quarterly as the PSB Board. The NGC Director chaired these meetings.

4.7.2 Staff Structure

Dinorwig is the largest centre of staff employment with other support functions (e.g. personnel and finance) also being located there. A detailed staff and function tree, as at 1994, is illustrated in Fig 6.

The staff of the Commercial Manager and the Business Development Manager were located at Bala House. Reporting directly to the Engineering Development Manager were the Head of Electrical Engineering, the Head of Mechanical Engineering, the Head of Control and Information Technology and the Contracts and Procurement Officer. All were located at Dinorwig with their respective staffs.

The Production Manager had the largest group of staff. Reporting directly to the Production Manager were the Head of Production at Ffestiniog whilst at Dinorwig, the Senior Maintenance Engineer, the Resources Planning Engineer, each of the Shift Production Engineers (SPEs) and the Warden, all reported directly to the Production Manager. Day maintenance staff at Ffestiniog report to two foremen who in turn report to the Head of Production. At Dinorwig, day maintenance staff report to three foremen who in turn report to the Senior Maintenance Engineer. At both stations the shift operating staff are divided into five shift teams each headed by a Shift Production Engineer (SPE). A shift at Dinorwig comprises the SPE, an Assistant SPE and three craftsmen and one production assistant. A shift at Ffestiniog comprises an SPE, a unit operator, an assistant unit operator and an auxiliary production assistant.

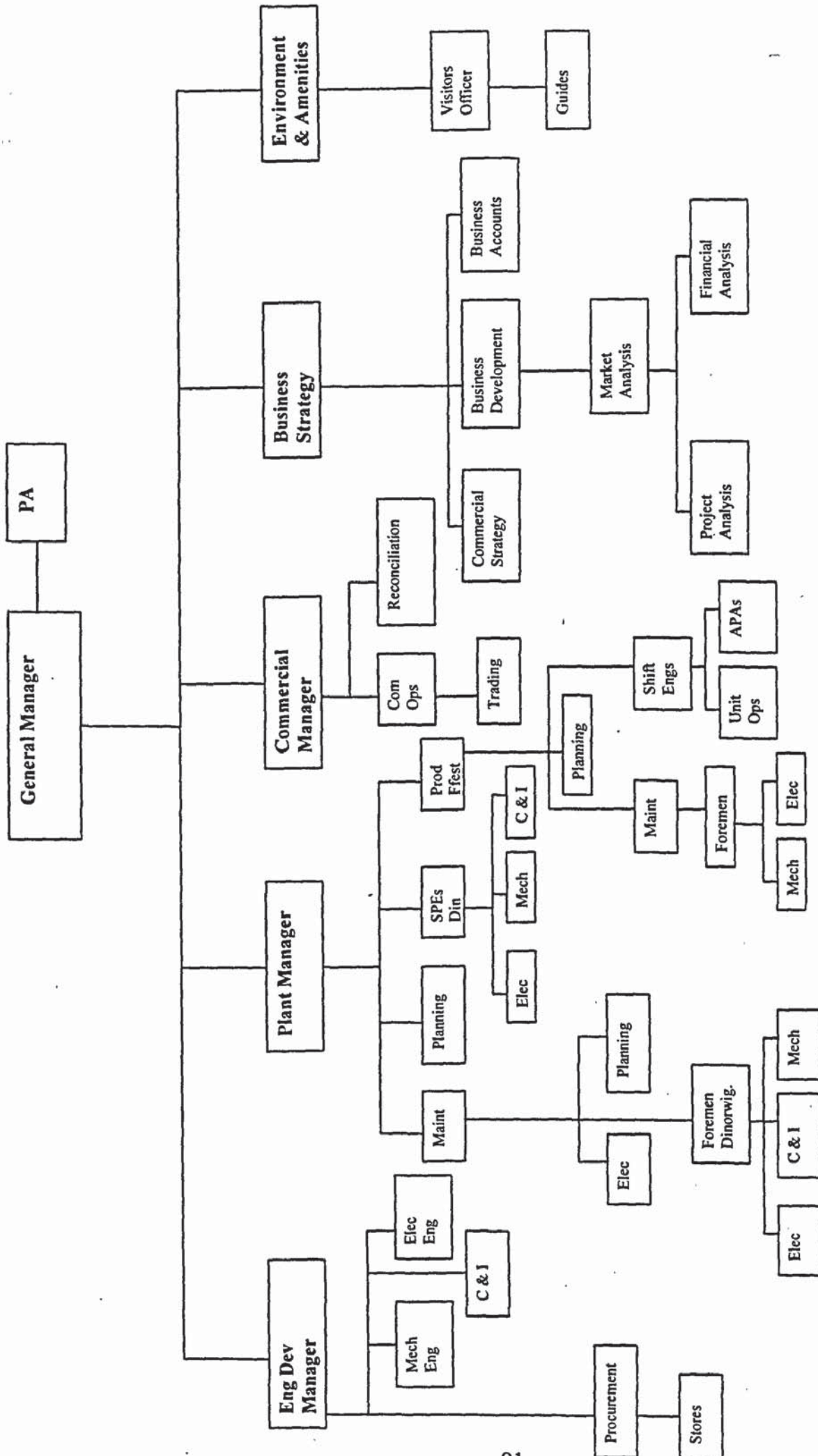


Figure 6: Simplified PSB Staff & Function Tree

4.7.3 Responsibilities

The operating staff are entirely responsible for the safe and efficient operation of the plant. The SPE receives information from the Commercial Manager about Pool Prices and indicative pumping profiles which provide the background to the operating regime of the power station. This information is a rolling programme which is updated daily.

The operating staff are responsible for the release of plant for maintenance either by day staff or by contractors. The operating staff must hand over the plant in a condition which is safe from the system i.e. isolated, earthed, drained, vented, purged. The NGC Safety Rules apply to all plant connected to the system and plant must be released and worked on in accordance with those Rules. The operations staff are responsible for the issue of the safety documents under which work and testing can take place.

The Engineering Development Manager holds an Engineering Development Meeting with his direct reports soon after the PSB Executive Meeting. The Production Manager does not have an equivalent meeting for his function. A morning meeting takes place every weekday at Dinorwig with the SPE, the Resource Planning Engineer and the Senior Maintenance Engineer. This meeting is used to discuss and make decisions on the rolling programme of work maintenance and testing. It is an essential liaison meeting between the various functions.

4.8 Staff Liaison Arrangements within PSB

Arrangements are in place for formal consultation between management and staff. A local Council meets quarterly and is the forum for consultation between PSB management and staff representatives. In addition there are separate Health and Safety Advisory Committees (HESACs) at Dinorwig and at Ffestiniog. These Committees are established in accordance with a model constitution agreed between the Trade Unions and NGC and meet the requirements of the Safety Representatives and Safety Committees Regulations. The Safety Representatives at the respective sites are members of the appropriate local HESAC. The local HESACs meet approximately every 2 months.

In 1996 there was no formally appointed Safety Representative at Bala House although it has been proposed by management that the Dinorwig HESAC should embrace Bala

House in its constituency and a staff representative from Bala House should be encouraged to attend.

4.9 PSB in the Context of NGC

Because of the operational characteristics and capabilities of the pumped storage stations they have been seen historically as an essential tool in the efficient and secure operation of the grid system. They provide very rapid response spare generating capacity in the event of a sudden increase in demand or sudden loss of generating plant and can therefore provide an extremely effective means of ensuring system stability. Prior to privatisation, the pumped storage stations were seen primarily in this strategic role rather than as competitive generators. It is for this reason that they were treated differently at privatisation and were allocated to NGC rather than being allocated to one of the other GENCOs. Although the strategic role is still just as important, PSB is now firmly established as an independent generator competing vigorously with the other generating companies.

Although PSB was an integral part of NGC, many factors combined to establish and reinforce its separate identity and to emphasise how different it was from the rest of NGC. The main core business of NGC is the operation of the transmission system. In contrast, the Pumped Storage Business is, to some extent a "fringe activity," employing a very small number of people. NGC also operates the Pool system and had to be seen to deal fairly and confidentially with all the generating companies. For this reason the elaborate precautions that were taken to ensure that PSB affairs were kept separate from the rest of NGC including "Chinese Walls," had the effect of increasing the isolation of PSB from the rest of NGC.

In fact PSB was very much a self-contained business with little need for support from the corporate centre of NGC, a position which was actively promoted and encouraged by its independently minded, first General Manager. The two power stations are located in rural North Wales a considerable distance from the administrative headquarters at Bala House and very remote from NGC Headquarters in Coventry.

4.10 Additional Factors Specific to PSB

A high proportion of the workforce speaks Welsh as a first language; about 60% at Dinorwig and about 80% at Ffestiniog and most of the workforce is drawn from the local community. The main historical occupations in the communities are slate quarrying and sheep farming. The workforce is very stable with many staff having been employed at the same site since, or in some cases before commissioning, that is to say during construction. The age profile is generally high.

Another historical factor which may have an influence on the cultural background of PSB is that prior to the commissioning of Dinorwig, Ffestiniog was the major station amongst a group of smaller hydro-stations in North Wales. The other stations have now either been closed or become assets of other generating companies. Ffestiniog has therefore moved from being the senior to junior partner within the memory of a large proportion of the workforce.

4.11 The Vulnerability of PSB in 1994

NGC itself was wholly owned by the RECs and during 1994, decisions were being taken on the flotation of NGC on the stock market. It was anticipated at that time that this would probably take place in May 1995. This had considerable implications for PSB. The precise form of any sale were not then known but PSB could have remained part of NGC or could have been sold off separately. Although the senior management of PSB may be particularly vulnerable in this situation there seems to be little evidence of any great concern by the bulk of the workforce.

Chapter 5

**PRE-1989
THE CULTURAL INHERITANCE**

The past is but the prologue.

Motto - The former Electricity Council 1958-1989

5.1 Introduction

This Chapter describes the initial stages of the research, which comprises an historical review of the nature of the industry and organisation, which was to be subject to major changes in the external context. The objective was to determine the features characterising the original organisation, in other words, the cultural inheritance. The analysis draws upon the author's own knowledge, supported as far as possible, by documented sources.

5.2 Overview

Any study of the safety culture of PSB must include an attempt to understand the overall culture of PSB itself and the forces and influences which have moulded it and which are still causing it to evolve. In this Chapter, an attempt is made to identify the main forces and influences shaping the organisation and the attitudes of its staff, in the years prior to privatisation.

PSB is a very young organisation, formed in 1989 at the same time as the formation of NGC. NGC itself grew out of the CEGB and the two power stations were originally designed, built and operated by the CEGB. Many of the staff now working in PSB and in NGC, were originally employed by the CEGB. The two power stations were therefore originally established at separate times and as separate managed units, within the CEGB culture, in the environment prevailing at the time. The integration of

Dinorwig and Ffestiniog as one business, coincided with the formation of the National Grid Division of the CEGB in the lead up to privatisation in 1989.

Between the time of commissioning of Ffestiniog (1963) and Dinorwig (1984) and the start of site observations and data collection, considerable changes had already taken place. These changes were in the environment external to the organisation as well as within the organisation itself. These environments are referred to by Waring, (1996), as the external context and the internal context respectively. Much of the change had taken place since 1989, when NGC and PSB were formed. During the period of the study, further fundamental changes were taking place. It is therefore appropriate to consider the forces and influences which have formed the culture and more specifically the safety culture, of PSB and to consider the extent to which they continue to shape the organisational and safety cultures.³

5.3 The External Environment Pre-1989

5.3.1 General

The external context in which the CEGB had existed for many years was to change completely with privatisation in 1989. Within relatively narrowly defined parameters the external environment was characterised by stability and certainty. The various external forces, pressures and expectations acting upon the CEGB were relatively constant and the agencies, institutions and organisations exerting influence were themselves relatively constant. These influences not only created the CEGB in the form in which it existed but also moulded its behaviour and culture.

5.3.2 Relations with Government

Considering these issues in more detail, perhaps the most significant single fact was that the CEGB was owned by the State and established under Statute with its authority and terms of reference prescribed in law. Whilst the CEGB's terms of reference were clear, they also had the effect of limiting and fixing its sphere of operation. (E.g. it could not own a coal mine or manufacture generating equipment). In fact the structure of the

³ It should be noted that the historical review of environmental and cultural issues leading up to the collection of research data specifically in the Pumped Storage Business, is based upon the personal experience of the researcher as a manager in the ESI during the period under consideration. (see Chapter 1)

whole Electricity Supply Industry (ESI) in the UK was determined by Act of Parliament. This had the effect of fixing the organisations comprising the ESI in a pre-determined and constant shape and also fixed the relationships between them.

The most senior posts in the ESI (Board Director level) were government appointments, which certainly underscored the nature of overall government control.

The CEGB was a major influence on the economy and therefore of considerable significance to the Government. The CEGB and indeed the whole of the ESI, was a very profitable nationalised industry often used as an instrument of government policy in relation, for example, to its contribution to the exchequer, its influence on the public sector borrowing requirement, the public sector investment programme or to its effect on employment in manufacturing suppliers. This resulted in considerable government influence (seen by some as interference) in for example, the choice of type and manufacturer of nuclear reactor or generating sets, the price of electricity and also in salary negotiations.

The fact that a general election could result in a change in the party of government meant that the senior management of the ESI had to make sure that they maintained reasonable relationships with all the major political parties. The influence of even the smaller parties is well illustrated by the fact that a major reorganisation of the ESI was proposed by a Committee chaired by Lord Plowden during the time of the Liberal/Labour pact (1977-78). The fact that the reorganisation did not go ahead was due to the refusal of the Liberal party to support the Bill brought forward by the then Secretary of State for Energy, Anthony Wedgwood-Benn. (Penhaligon, 1978).

A continuous and secure supply of electricity is of the greatest strategic significance to the country and therefore also to the government of the day. This is best illustrated by the part played by the ESI during the Miners' Strikes in which the contingency planning arrangements of the ESI were co-ordinated with the Department of Energy. The outcome of the 1984/85 strike for example, was seen by the government as essential to its own survival. By the same token, the efforts of the NUM to win this dispute was directed at preventing the generation of electricity and not simply at preventing the mining of coal (Ledger & Sallis, 1995).

5.3.3 Relations with Staff

The relationship between the CEGB and its own staff and the Trade Unions was clearly crucial not only to the outcome of the disputes referred to above but also in maintaining satisfactory industrial relations in an industry where withdrawal of labour could have immediate and devastating consequences for society and for the economy.

In fact the terms and conditions of the staff of the ESI were relatively good and Industrial Relations was carefully managed. Staff were rarely disaffected with their management and then not for any prolonged period. On occasions when the industrial staff of the CEGB were themselves in dispute, or when the sympathies of some of them, particularly in some of the mining areas, were tending to be with the mineworkers, the CEGB's professional engineering staff maintained the safe and secure operation of the system. According to Ledger and Sallis, (ibid.), who were respectively, CEGB Director of Operations and Electricity Council Director of Industrial Relations during the 1980s;

“the technical and scientific staff had an outstanding record of helping the industry during operational crises.”

Relationships therefore with the ESI Trade Unions were generally good and quite close and Trade Union influence was strong. Trade Union membership was not compulsory in the ESI but was close to 100%.

The statutory basis of the ESI organisation also established the Electricity Council which was a federal body, overseeing the Industry. The Electricity Council (EC) had its own Government appointed Chairman and Deputy Chairman and the Council itself was made up of the Chairman and Deputy Chairman of the CEGB and the Chairmen of the 12 Area Electricity Boards and the Scottish Boards. The EC itself had certain statutory responsibilities but in the main it was responsible for the national co-ordination of the ESI, relationships with Government, pensions, national negotiations and certain aspects of research and engineering as well as health and safety co-ordination. The EC had a relatively small staff, mainly based in London but with some regionally out-posted industrial relations and safety personnel.

The formal Industrial Relations arrangements within the industry were prescribed in National Industry Agreements with the Trade Unions and formed an elaborate series of interlocking negotiating and consultative committees at national, regional and local level. At national and regional level, these arrangements embraced joint committees of

CEGB and Area Electricity Board interests. The National Agreements were common to all ESI staff in a particular negotiating group with the consequence that events in one sector of the ESI had an impact on the rest of the ESI. There were four main National Agreements covering, Managerial, Technical, Clerical and Industrial staff respectively, each with its own negotiating committee structure. The Consultative committee structure embraced all staff groups and also included Health and Safety Committees (HESACs), at National, Regional and Local levels (HESAC Bulletin, 1978).

Management / Trade Union relationships on matters of health and safety were very good and health and safety was very rarely the subject of any contention. For example, at the time of the introduction of the Health and Safety at Work Act, a senior joint delegation of management and trade union representatives, went to the TUC, to persuade them not to insist on the formation of an Industrial Advisory Committee for the ESI but rather to allow the ESI to continue with its own arrangements for discussing health and safety at national level. (The delegation was successful in this endeavour).

When the Safety Representatives and Safety Committee Regulations, (1977) were introduced, the ESI trade unions and management drew up a nationally-agreed guidelines governing the application of the Regulations in the ESI. Although not legally enforceable, this had the effect of restricting the ability of the trade unions at local level to appoint more than a specific number of Safety Representatives. The guidelines successfully avoided a proliferation of safety representatives in locations where there were many industrial trade unions, by allowing safety representatives of a majority union to represent the interests of members of another union.

5.3.4 Relations with Customers

The fact that the structure of the ESI was set down in statute meant that the CEGB had only a small number of customers, the 12 Area Electricity Boards and a few large industrial users, such as British Rail, who took their supply directly from the Grid. It also had effectively unchanging major suppliers notably the National Coal Board (on which it depended for some 80% of its fuel supplies), the Atomic Energy Authority and the major British plant manufacturers and power station construction companies.

Within this scenario, relationships were more or less constant and stable from one year to the next and the customers for electricity were all subject to the CEGB's Bulk Supply Tariff (BST). The CEGB's monopoly position ensured that the setting of the BST assured its income for the following year, subject only to the vagaries of electricity demand over which even the CEGB had no direct control. Demand for electrical energy was determined largely by the level of economic activity and by the weather. The CEGB therefore had no direct influence on the market for its product.

The CEGB existed therefore in a low risk commercial environment which was stable and largely predictable.

5.3.5 Relations with Enforcing Authorities

The enforcing authorities had a close and generally good relationship with the CEGB and since it was a large, high-profile organisation, it tended to be the focus for the attention of HSE and was certainly regarded as a good and responsible employer by HSE. For example, serious accidents within CEGB would be the subject of an internal Board of Inquiry but the HSE would almost invariably allow CEGB to complete its own inquiry and provide HSE with a Report rather than institute their own inquiry. In this and other respects, relationships with the HSE were generally good and constructive.

5.3.6 Other Issues

Although there were generally power inflows from the Scottish interconnection and the cross-channel link with France, the CEGB had effectively no competition and its monopoly position and its size gave it a dominant position within the ESI. Whilst there was no external competition, it should be noted that the CEGB operated a merit order, based on thermal efficiency, which determined the order in which power stations would generate to meet demand. This led to considerable internal competition between power stations for relative positions on the merit order. The stations in the closure programme were those at the bottom of the merit order. The statute under which it was established, The Electricity Act, 1957, required CEGB to have generation available to meet demand; in other words an obligation to supply.

Because of the long lead times for construction of the thermal stations then being built, the CEGB construction programme was planned very many years ahead, based on an anticipated demand, over which it had no control. The CEGB naturally took a somewhat

Table 5.1 - Elements Characterising the pre-1989 External Environment of the CEGB

Characteristics of External Environment:

- State ownership
- Organisation of ESI fixed and established by statute
- Prescribed terms of Reference
- Limitations on CEGB Organisation and Activities
- Senior posts appointed by Government
- CEGB nationally very important economically and strategically
- CEGB dominant within ESI
- CEGB subject to constant Government Pressure
- CEGB used as instrument of Government policy
- CEGB integral part of interlocking ESI
- Customers fixed and unchanging
- Suppliers largely fixed and unchanging
- No external competition
- No direct influence on market for electricity
- Monopoly position and ability to fix tariff for product
- Low risk commercial environment
- CEGB part of interlocking ESI Industrial Relations Scene
- Pay and Conditions subject to National Agreements jointly with other ESI Employing Organisations
- Elaborate Industrial Relations machinery for negotiation and consultations
- Generally good Industrial Relations climate
- Strong Trade Union influence
- ESI used as a conflict area by other workers (e.g. NUM)
- Clear societal purpose arising from Terms of Reference
- Future generally predictable
- High profile with HSE and respected by them
- Stable relatively unchanging environment

cautious view and consequently the plant investment programme was often criticised as being too ambitious when the predicted economic growth, and therefore electricity demand, failed to materialise.

The CEGB's obligation to ensure a sufficient and secure supply of electrical energy for the nation gave it a clear and overriding societal purpose. The CEGB was naturally subject to pressure from various groups notably on environmental issues concerning nuclear power, acid rain, reusable energy generation sources, planning consents for power stations, overhead lines, cables and substations. A substantial technical and public relations effort was devoted to these affairs by CEGB.

Table 5.2 - Elements Characterising the Points of Influence in the pre-1989 CEGB

Major Points of Influence:

- Government
- Government Agencies
- Rest of ESI - Area Boards, Electricity Council etc.
- NCB
- AEA
- Manufacturers
- Political Parties
- Public
- Pressure Groups e.g. Environmental
- ESI Trade Unions
- NUM

5.2.7 Summary

This review of the external environment in which CEGB existed until 1989 is summarised in Table 5.1, which lists the elements characterising the external environmental forces, pressures and expectations relevant to and reacting with the CEGB. Table 5.2 illustrates the pressure points through which the influences were focused.

5.4 The CEGB Organisational Culture

5.4.1 General

The CEGB was created and existed in the external context described above and its own characteristics and culture were formed and influenced by the pressures outlined. Given the fixed and statutory nature of its Terms of Reference and stable external environment, the CEGB was essentially a conservative organisation with a clear and simple sense of purpose. This extended to a clear sense of national duty to ensure a safe, sufficient and secure supply of electrical energy for the nation;

“Continuity of supply came before everything” (Ledger & Sallis, 1995).

The strategic importance of having a mix of generation fuel sources was recognised and was part of long term planning. The importance of electricity supply to society and the economy and the importance of the CEGB itself to large sectors of UK industry outlined in 5.3.2 above, resulted inevitably in a close, though not always warm relationship, between CEGB senior management and Government. The contingency arrangements around the 1984 miners’ strike for example, were almost on the lines of a military conflict and CEGB senior management were aware that the fate of the government certainly depended on the outcome. For reasons such as this the management cadre of the CEGB had a considerable sense of national importance and of status.

The CEGB was highly structured and for most of its life the structure was stable and unchanged, comprising a three-tier organisation with a London Headquarters, five Regions and Local Management Units. A constant and unchanging external environment did not provide much motivation for internal change. Internally, the organisation was a hierarchical command structure with many layers of management, a reflection of the National Agreements for different staff groups.

5.4.2 Technical Domination

The CEGB with its dominance within the ESI and its monopoly position was not driven by commercial and market pressures but mainly by technical concerns. It was truly a technocratic organisation and a substantial proportion of its employees were professional engineers and scientists. The senior management posts of the CEGB were overwhelmingly occupied by engineers. The CEGB had a powerful belief in technical

excellence and undoubtedly was very capable technically and scientifically, with extremely strong resources in these areas. It was much given to producing technical and scientific standards and the CEGB would often demand higher than normal standards. For example, the CEGB specification for overhead travelling cranes was significantly more onerous than normal commercial cranes and was consequently more expensive. Even within the ESI the CEGB was regarded as technically arrogant and as "gilding the lily" in engineering terms. Nevertheless the CEGB was widely, if sometimes reluctantly, admired as an organisation with technical competence and integrity.

5.4.3 Management Perspectives

The CEGB was a large monolithic organisation in the sense that it was directed from the centre by strong chairmen. Policy in most areas ran throughout the organisation. Whilst the CEGB was essentially centralist in nature, this tendency was accompanied by a strong belief in the status and authority of line management. Regional Directors were very influential within the CEGB as a whole and enjoyed considerable power within their respective regions. By the same token, Location Managers were very powerful in their own locations. In this sense the CEGB was a "feudal" organisation. The organisation of the CEGB relied on an elaborate structure of line and functional management meetings of which the formal industrial relations structure was an example.

5.4.4 Staff Beliefs

The CEGB was acknowledged by staff and by trade unions to be a good employer and offered terms and conditions of employment which were, by most standards, exemplary. Most staff believed that working for CEGB was a lifetime career and that it would certainly be possible to complete a working lifetime in an industry which was an essential and permanent part of national life. Long service awards for 20, 30, 40 and occasionally even for 50 years, were a common feature. Since terms and conditions were set out in National Agreements, it was possible for employees to have continuous service even though their previous employment may have been in another part of the ESI or may have pre-dated the existence of CEGB.

Throughout the life of the CEGB, there was a permanent station closure programme, as older stations came to decommissioning but a combination of severance and relocation

arrangements usually dealt with the staff affected without too much difficulty. The CEGB therefore bred a sense of loyalty in its employees and they believed that their loyalty would be returned. Most employees would probably feel some pride in working for an organisation which they felt was well run, highly regarded and fulfilling an important function in the life of the country and which looked after its employees well.

5.4.5 Health and Safety Organisation

Occupational health arrangements were well developed with an in-house Occupational health service and safety was accorded a high status in CEGB with a Director specifically appointed to be responsible for Health and Safety. A sizeable team of well qualified safety professionals was employed by the CEGB. The grade of the most senior of them was equivalent to that of a Power Station manager.

5.4.6 Other Issues

The CEGB was seen by its staff as a safe organisation to work for and indeed was generally seen as being a sound organisation technically, managerially and financially. Its staff and management would tend to see the future as secure and certain. Internal competition was keen in relation to merit order rating but technical competence and efficiency were vigorously pursued in the search for thermal efficiency improvements, tighter outage deadlines and solutions to technical problems.

In common with the rest of the ESI, CEGB was very profitable in the state sector and this probably added to a general feeling of comfort by management which could perhaps be described as a combination of technical and managerial efficiency tinged with complacency. The CEGB was essentially engineering driven and the factors which were important may be summarised as follows:

- Continuity of supply
- Efficiency
- Performance
- Output
- Availability
- Safety (Technical)
- Societal contribution (e.g. miners' strike)

The features characterising the CEGB pre-1989 are summarised in Table 5.3.

Table 5.3 - Summary of Features Characterising the CEGB pre-1989

<i>Structure:</i>	<i>Cultural Values:</i>
<ul style="list-style-type: none"> ▪ Bureaucratic ▪ Hierarchical command structure – semi-military structure ▪ Highly structured and stable ▪ Fixed grading structures ▪ Meeting oriented – committee management ▪ Monolithic – feudal ▪ Centralist ▪ Formal ▪ Internal technical competition ▪ Safety staff with high status ▪ Elaborate layered negotiating and consultative committees ▪ Strong Regional power bases 	<ul style="list-style-type: none"> ▪ Engineer dominated ▪ Technocratic ▪ Technical integrity ▪ Belief in technical excellence ▪ Given to technical and performance standards ▪ Technically arrogant ▪ Insular ▪ Internally technically competitive ▪ Centralist ▪ Formal ▪ Lavish ▪ Think big ▪ Conservative ▪ Achievement oriented ▪ Strong belief in the role of line management ▪ Good employment practices ▪ Good terms and conditions for employees ▪ Good industrial relations ▪ Belief in a secure and stable future ▪ Lifetime career commitment for most staff ▪ Strongly stated belief in the importance of health and safety ▪ Clear sense of purpose and public duty ▪ Pride in organisation and role in society ▪ Rules, systems and procedure dominated ▪ High priority to operational safety ▪ Low appreciation of human factors in safety

5.5 The Safety Culture of the CEGB

5.5.1 General

The CEGB's investment in safety was, by any standards, substantial. The safety aspects of design, construction, operation and maintenance of conventional and nuclear power plant are self evidently very demanding. The legislative requirements in themselves are also self evidently very demanding.

It has already been noted that the CEGB was an organisation dominated by technology and very largely managed by engineers. A very high proportion of senior staff were people with earlier operational experience. It has also been noted that the CEGB existed in a fairly stable environment. Whilst the technology was being pushed forward to achieve greater efficiency and availability, the principles of operation of power stations and the transmission system remained essentially the same.

Safe operational procedures were determined by a combination of the laws of physics, legislative requirements and experience. Therefore the principles behind the Safety Rules had changed very little over many years. Senior staff with previous operational experience could still relate to current operational practice. These facts created the conditions in which there was a common thread of understanding of operational issues from current operational staff to the most senior managers running the organisation. Against this background it is not surprising that there was a generally held belief, at all levels in the organisation, that safety was very important.

5.5.2 Safety Rules

Safety Rules had been built up in an evolutionary way over many years of experience and covered electrical, mechanical and radiological safety. Each set of Rules was backed up by a large body of supporting procedures. Whilst the principles of the Rules remained constant, the CEGB was committed to continuing improvement.

A major exercise was initiated by the CEGB Executive in the late 1970s, to combine the then separate Electrical Rules and Mechanical Rules into a single combined set of Safety Rules. The objectives of this exercise are themselves indicative of the CEGB Safety Culture:

- To raise the standard of mechanical safety to that already demanded for electrical safety

- To simplify the Rules into principles and to separate out procedural issues into supporting Codes of Practice
- To eliminate unnecessary differences in Regional procedures and to bring together best practices in model procedures
- To ensure no diminution in safety standards

An advisory committee was established to develop the new (4th Edition) combined Electrical and Mechanical Safety Rules. This Electrical and Mechanical Safety Rules Advisory Committee (EMSAC), was composed entirely of managers with operational experience and was chaired by a senior line manager.⁴ EMSAC reported to the CEGB Main Safety Rules Committee, which was made up of members of the CEGB Executive, including the five Regional Directors General. During the development of the 4th Edition Safety Rules, the members of the CEGB Executive took a personal and direct interest in steering the direction of the Rules and occasionally insisted on certain specific issues being dealt with in a particular way. The significance of this is that it illustrates that the most senior managers in the CEGB were:

- (a) sufficiently interested and
- (b) sufficiently knowledgeable

to exert a continuing, direct and personal interest in the development of the Safety Rules. The new 4th Edition Safety Rules and supporting documentation were introduced on January 31st 1982. No new principles were involved but procedures were in many respects, different and the introduction was accompanied by a major training exercise costing £2M (1982 prices).

5.5.3 Training

Safety training in the CEGB was given considerable importance and in-house training centres existed in each Region, as well as a National Authorisation and Safety Training Centre. Classroom, practical and simulator training was all widely available. Those formally Authorised for activities under the Safety Rules, first received on-job and formal off-job training before facing an Authorisation interview. A high standard of technical competence was demanded and the Authorisations which allowed safety

⁴ The author of this thesis was a member of this EMSAC throughout its existence.

precautions to be applied (isolation, earthing etc.) and the issue of Permits for Work, were generally restricted to professional engineering staff.

5.5.4 Advice

The CEGB also maintained a strong in-house safety advisory service employing well qualified safety engineers in relatively senior positions as well as in managerial positions. These people were functionally responsible to the Director of Health and Safety. As well as providing policy advice, the safety staff also undertook audits of safety performance. In addition, the advice of the Electricity Council safety engineers was also available to CEGB management. In general ESI safety staff were recruited from within the Industry and almost invariably had several previous years of experience as operational engineers or as station chemists before obtaining safety qualifications. The safety professionals were accorded considerable respect by CEGB managers.

5.5.5 Staff Safety Representatives and Consultation

The corporatist culture of the Industry is reflected in the arrangements for staff consultation and safety representatives. It has been noted in 5.3.3 that a national management/trade union approach led to an agreement to retain the ESI national consultative machinery rather than an Industry Advisory Committee. In addition a national agreement was reached which effectively limited the number of safety representatives in any one location and allowed for trade union safety representatives to represent members of other unions in appropriate circumstances. It should also be noted that it was agreed that safety representative training would be carried out jointly by management and trade union tutors to an agreed programme. In practice, management representatives gave many of the scheduled trade union sessions, at the request of trade union tutors, who pleaded other commitments.

In these several ways the trade unions in effect, voluntarily relinquished the statutory rights they could have exercised. Relationships with safety representatives and full-time trade union officers were good and it is evident that the arrangements described would not have been established or maintained if this had not been the case.

5.5.6 Formal Inquiry Procedures and Other Issues

The CEEB had a well-developed formal inquiry procedure which was accepted by the ESI Trade Unions and the HSE as being fair and thorough and which was the basis for a model procedure adopted by the Area Electricity Boards. The CEEB inquiry was very rigorous in questioning and in pursuing technical and scientific inquiries. A Board of Inquiry would be established by a Main CEEB Board Member. Inquiry members would be senior managers and the Board would be chaired by a Director from a Region other than the one in which the incident took place.

The CEEB had close relations with the HSE at national level and in general, the HSE had considerable respect for the safety professionalism of the CEEB. In terms of general safety, not associated with the operation of the system, standards were more variable between locations. There was less management emphasis on general safety than on operational safety and general safety issues were less likely to be subject to safety audit. Training courses however were widely available on general safety issues such as lifting and moving, scaffolding, rigging and slinging, safety supervision etc. The presence of a well developed, progressive Occupational Health service within the CEEB, offering proactive health care and various other services has already been noted.

5.5.7 Hinton Trophy

One of the most prestigious awards a CEEB location could obtain was the Hinton Trophy, named after Lord Hinton of Bankside, the first chairman of the CEEB. The award was made annually for management excellence but a very significant component of the judging criteria was safety performance. The small judging team who visited the regional finalists comprised CEEB Directors and a Regional Safety Officer. This further illustrated the value placed on safety by the top management of the CEEB and did so in a way which conveys its importance directly to location managers.

5.5.8 Safety Wise 85

A further insight into the safety culture of the ESI is provided by a safety campaign mounted in 1985 and promoted throughout the industry, known as Safety Wise 85. This was planned as a response to the Site Safe 83 safety campaign in the construction industry. The latter campaign was based on the premise that if attitudes amongst workers could be changed, behaviour would change and the result would be a reduction

in accidents. As later demonstrated by Glendon & Hale, (1984), a reduction in accidents did not occur. The campaign in the ESI was mounted in a similar vein, with competitions, posters, mugs, coasters etc. (“Meretricious trash” in the words of a senior CEGB manager at the time), in an attempt to raise awareness. The outcome was that accident rates actually rose in that year. This was rationalised later almost as a success, in that the result had been to raise awareness and that people were more likely to report accidents. More probably, the episode indicates a simplistic functionalist world view, specifically in relation to the changing of attitudes, which was predominantly held within the ESI.

5.5.9 Summary

Any attempt to build a picture of CEGB Safety Culture is made difficult by the absence of quantified data on the views, beliefs and attitudes of the bulk of the workforce. Nevertheless some conclusions may be drawn from the known views and decisions of many individual managers, senior executives and Directors and the factual evidence of procedures and systems.

The CEGB might at first be seen as a model of Weberian bureaucracy in that it was state owned and its position was fixed by statute within the overall statutory structure of the ESI. Its organisational structure was hierarchical and the labyrinthine industrial relations committee structure would appear to signal an ossified and immutable bureaucracy. Its procedures were almost all encompassing, thorough and technically excellent. It was dominant within its own industry and was a monopoly supplier with no direct contact with the market for its product and no influence over demand. It was the dominant customer for its major supplier, the National Coal Board, its budget was huge and its management were confident and proud of its position within the country and its record of achievement. Staff also were conscious of the vital role of the CEGB, they felt secure and were generally aware that conditions of employment were good and that the record of the CEGB in dealing with its rolling closure programme was exemplary.

The picture could be said to be one of a self-satisfied organisation, which one might assume to be arrogant and at the same time, complacent. All these features were present to a degree and one might assume that such a monopolistic, dominant and bureaucratic organisation would simply evolve into an inefficient torpor. However, a study of the

CEGB's preparation for the 1984/85 miners' strike and the conduct of the organisation during that period, (Ledger & Sallis, 1995), demonstrates that CEGB was an innovative, courageous and resourceful organisation, with leadership, management and staff of an extremely high quality.

The difference between performance and expectation may lie in the fact that the CEGB could perhaps, more accurately be described as a technocracy rather than a bureaucracy. It was led by engineers who dominated the management ranks to the highest level. Achievement was measured in technical rather than financial terms. What was important is set out in Section 5.3.6 and may be summarised as efficiency, performance, output, availability and above all, continuity of supply. Managers were judged against these criteria. Good industrial relations and safety performance were taken as necessary to enable technical targets to be met.

Additionally, it should be noted that since electricity cannot be stored, supply must meet demand on a real time basis, 24 hours a day, 365 days a year. Operational managers and staff were used to dealing with crises in real time and most of the senior managers had seen operational service, in power stations, transmission districts or grid control centres. The difference in activity modes (routine, high-tempo and emergency), noted by La Porte and Consolini, (1989), were a daily feature of operational life in all these locations. Directors and senior managers were given to recounting their past operational experience almost as war stories. Operational service was the route to the top and those without that background were sometimes relatively isolated in discussion. The "heroes" of the organisation were successful station managers.

Also, the rolling closure programme, combined with the thermal efficiency merit order, was a compelling driver for performance and productivity. A station at the bottom of the merit order was likely to be closed and this fact certainly fostered a highly competitive spirit between the management of different stations which was effectively conveyed to all staff. Equally there was great competition to remain at the top of the merit order. The Efficiency Engineer at Ratcliffe power station, top of the order in the 1980s, used to post performance graphs outside his office door.

As Handy, (1993) and Mintzberg, (1989), recognised, different cultures can co-exist in one organisation and this was so in different parts of the CEGB. For example, in research and development, the career and salary structures allowed for a somewhat different progression path, appropriate to researchers, whilst the corporate departments, such as finance and secretarial, were probably more truly bureaucratic. The dominant culture however was the technocratic, achievement oriented, operational culture.

Turning now to the implications for safety culture, there is no doubt that CEGB had well developed Safety Rules and procedures dealing with operational work, that considerable effort went into associated training and rigorous Authorisation systems. High quality technical advice on safety issues was readily available. Considerable resources were expended on safety aspects of design and operation. The elaborate Grid Control Centre arrangements for the safe release of parts of the transmission system represented, in itself, a very large investment in safety. Altogether the resources devoted to ensuring the safe operation and maintenance of the system were very large and elaborate paper systems covered practically every technical safety issue. Technical staff and senior management shared a common understanding of technical safety issues and a belief in the importance of safety. They generally believed that CEGB had very high safety standards.

Whilst the profile of safety and the general attitude to safety in the CEGB were generally good in relation to many industries, it is not easy to justify the "high safety standard" when compared to performance of international companies. Towards the very end of the life of the CEGB, the then Head of Industrial Safety instituted a comparison of safety performance with the best international companies, notably Dupont. Although comparisons of safety performance are notoriously difficult, this study demonstrated that in respect of accident rates, the CEGB was orders of magnitude worse than the best performer.

There is therefore an apparent paradox in that CEGB was, on the one hand, an organisation devoting considerable financial and technical resources to safety and in which the management and staff genuinely believed that safety was very important and that their safety standards were very good and yet, on the other hand, CEGB experienced accident rates far higher than the best industrial performers. This is perhaps

explained by the fact that the CEGB culture was more likely to lead to internal than external comparisons and was more prone to self-congratulation than self-criticism. In safety terms, the factors that were important in the CEGB, pre- 1989 were:

- Operational safety
- Safety of plant
- Good industrial relations on safety

A summary of the features characterising the CEGB safety culture pre-1989 is given in Table 5.4.

Table 5.4 - Summary of Features Characterising the Safety Culture of the CEGB pre-1989

<i>Structural:</i>	<i>Cultural Values:</i>
<ul style="list-style-type: none"> ▪ Layered formal consultative machinery for health and safety ▪ Safety Representatives and Safety Committee Regulations embedded into the existing machinery by national agreement ▪ Well developed safety rules and procedures for operational safety ▪ Well developed inquiry procedures (High status representation) ▪ Authorisation hierarchical and related to grading structure (qualifications) ▪ Heavy investment in safety (e.g. nuclear, grid control etc.) ▪ Tight specification of safety features of plant ▪ Heavy investment in safety training (e.g. Authorisation training centres) ▪ Competent well qualified in-house safety advisors (ex-operational) ▪ Hinton Trophy award heavily based on safety performance 	<ul style="list-style-type: none"> ▪ Safety important with emphasis on operational safety ▪ Non-operational safety not accorded same attention ▪ Safety training important ▪ Strongly stated belief in importance of safety ▪ Over-reliance on procedural protection ▪ Poor appreciation of human factors and human error ▪ Technical safety understood at top level of CEGB ▪ Safety rules developed by high level group and overseen by top level management ▪ High status and respect for in-house safety advisors ▪ Good operational safety performance but not world class on safety overall ▪ Excellent staff relations on safety ▪ Prestigious awards largely based on safety performance ▪ Superior attitude tending towards insular

Chapter 6

**POST-1989
THE CHANGED ENVIRONMENT**

The old order changeth, yielding place to new

Alfred, Lord Tennyson 1809-1892

6.1 The External Environment 1989-Present

6.1.1 Introduction

This Chapter describes the research which comprised the final stages of the historical review, covering the period from 1989, the start of the privatisation process, to 1994, the start of direct observation and data collection. As with Chapter 5, the analysis draws upon the author's own knowledge of events and uses documented sources insofar as they were available to the author. During the period covered by this Chapter, the author was Safety Advisor to NGC and manager of the NGC Health and Safety Branch. (See footnote in section 6.2.2 and section 1.4 in Chapter 1.)

An overview of evolution of the pumped storage business, from commissioning of the two power stations to the creation of an independent company, has been given in Chapter 4. Chapter 5 provides an analysis of the forces and influences shaping the organisation in the years preceding privatisation. This Chapter provides a detailed analysis of the changes taking place in the environment in which the new NGC and PSB organisations were formed and which therefore moulded their development.

It is also important to recognise that since PSB was part of NGC it was therefore subject to the internal influences and pressures of the parent body but that PSB also had direct contacts with the external environment that were, in certain respects, totally independent of NGC. This arose because PSB, as an independent generating company, had a direct interface with the market for electricity, ("the Pool"). This aspect of PSB's operations had to be kept confidential from NGC, who were responsible for managing the pool. PSB therefore presented some faces to the internal NGC environment and it presented other faces direct to the external environment, quite independent of NGC.

6.1.2 Structural Changes

The Electricity Act 1989 abolished the previous ESI structure and established new companies in its place. The new private Companies were initially wholly owned by the Government, with stock market flotation following some time afterwards. The Companies were not all floated simultaneously but for the purposes of this analysis, the transitional stage between privatisation and flotation will be ignored. The main structural changes to the ESI brought about by privatisation, have been summarised in Chapter 3. The Area Electricity Boards became Regional Electricity Companies (RECs), and were relatively unaffected. The CEBG on the other hand, was dismantled altogether and formed into three large Generating Companies and NGC. Although NGC contained a generating business it remained overwhelmingly a transmission company. (The functions of NGC are outlined in Chapter 4). The transmission function in England and Wales that had previously been managed as part of a single integrated generation and transmission organisation, was therefore separated from the generating function, within the new structure.

The change of structure was accompanied by perhaps the single most significant change, the change of ownership. The twelve RECs and the three CEBG successor GENCOs were floated on the stock market as public limited companies although it should be noted that the initial flotation of the GENCOs was only a partial sale with the Government retaining a substantial shareholding for later sale. In the case of Nuclear Electric, the Government retained all the shares and did not initially float the Company. In case of the RECs, the Government retained a 'golden share' which entitled the Government to exercise control, in certain important areas, over the structure and activities of the RECs. (e.g. no REC is allowed to generate more than 15% of its own electricity demand and no REC or other company could acquire control of a REC for a period of 5 years). The spate of take-overs and mergers following the expiry of this period introduced further structural and ownership changes and much more uncertainty.

The former Electricity Council became the Electricity Association, wholly owned by the Generation, Transmission and Distribution Companies and with none of its former authority. The Electricity Association became a Trade Association undertaking only those activities for which the member Companies were prepared to pay. It has already

been noted (Section 4.2) that NGC was created as a wholly owned subsidiary of the RECs. The environmental background in terms of ownership was therefore completely different after 1989, not only for NGC but for the whole of the ESI. Private ownership did not mean total freedom from Government constraint in that continuing share ownership by the Government meant that its interests could not be ignored. Certain specific constraints were put in place as outlined above. All the Generating, Transmission and Distribution Companies had to be licensed under the Electricity Act 1989 to undertake their activities and they were required to operate within the terms of those licences.

6.1.3 Regulation

The legislation establishing the new ESI structure also established the Office For Electricity Regulation (OFFER) presided over by the Director General of the Electricity Supply, Professor Stephen Littlechild. (Professor Littlechild being the academic who developed the RPI-X formula.) Those aspects of the ESI which were a monopoly and therefore not subject to competition, were subject to OFFER's regulatory regime. This applies specifically to the transmission and the distribution activities. By means of periodic regulatory reviews, OFFER can fix a 'price cap' based on the formula $RPI - X\% / yr$. The main source of NGC's income is from the charges for the use of the transmission system. The formula $RPI - 3\% / annum$ was set by OFFER at the first price review for NGC, which therefore faced an externally imposed, fixed downward pressure on its main source of revenue. Whilst NGC is now free from direct Government ownership and control, the Government has set in place a powerful regulatory mechanism. Yet Government remains distanced from the decisions of OFFER and the consequences of those decisions.

6.1.4 Commercial Freedom

As a wholly-owned subsidiary of the RECs, NGC must submit its medium term Business Plan to the Holding Company, National Grid Holdings (NGH). But the day-to-day activities of the operating company are free from interference by NGH. Post privatisation, NGC Board Directors are no longer appointed by the Government. The Company is free to explore and exploit commercial opportunities except where specifically prevented by its Transmission or Generation Licence. This includes the

freedom to seek commercial opportunities outside the main business, including overseas investment opportunities.

The external environment for NGC is therefore much freer than hitherto, in spite of continuing constraints. The Company is exposed to a larger external environment that in some cases, such as in overseas activities, also exposes the Company to international competition and to new competitors and potential partners.

Although the Company is not subject to direct Government pressure, the regulatory and licensing regime ensures that it remains subject to indirect pressure which is potentially an extremely powerful form of influence for any future Government.

Although free of direct Government control the ESI remains firmly in the public political arena as is indicated by the reaction by of media, the public and by politicians, to price rises, profits and above all, to Directors remuneration.

6.1.5 Financial Pressures

The influence of OFFER in limiting income by the price cap mechanism is accompanied by commitments to profit growth made by the ESI Companies at privatisation. The NGC prospectus, committed the Company to profit growth of 5% / annum. The new environment is therefore one in which NGC is subject to downward pressure, in real terms, on its main source of income and relentless upward pressure (from the RECs and City Institutions) on its profit growth. The fact that the ESI Companies were privatised at the same time and that they can all be compared by various performance indices, contributes to intense peer pressure. No one Company can afford to be regarded by the City as less committed to profit growth or less aggressive in its concern with reducing costs or headcount. The environment is one which encourages competitive 'downsizing'.

PSB however, is not a regulated monopoly and must compete with other GENCOs in the real market of the Pool. It is therefore not subject to the surrogate market force of a regulatory price cap. The future of PSB depends absolutely on its success and profitability in the market, in which it is competing, not only with the CEGB successor Companies and the Scottish GENCOs but also with new entrants to the Generating market.

An external environment which was mature and predictable, is now unstable and uncertain. For PSB in particular, a low risk commercial environment has become a high risk commercial environment. The 'obligation to supply' no longer applies to the GENCOs, the legislation being intended to ensure that market forces ensure sufficient supply to meet demand.

6.1.6 Pressure Groups and Enforcing Authorities

An unchanging factor in the external environment is the environmental pressure on NGC focused mainly on amenity and planning considerations and increasingly on concern over the alleged health effects of EMFs. The ESI also remains a high profile industry for the health and safety enforcing authorities and one which they may be expected to be watching closely for any signs that increased commercial pressures may result in a lowering of standards.

6.1.7 Trade Unions, National Bargaining and Consultation

The influence of the Trade Unions, very strong before 1989, has become increasingly marginalised as a result of a number of factors. All the newly privatised ESI Companies began to free themselves from the collective National Industry Agreements on terms and conditions of employment and began to establish their own Company Agreements with their staff. Within two years of privatisation the National Negotiating bodies had ceased to exist. The rapid erosion of Trade Union negotiating influence nationally was accompanied by the substantial downsizing referred to above, further weakening Trade Union influence and reducing membership.

The Trade Unions had prevailed upon the then Secretary of State for Energy, Cecil Parkinson, to include a requirement in the generation, transmission and distribution licence conditions that the Companies must continue to co-operate and to consult with the Trade Unions on matters of health and safety:

"It shall be the duty of the licensee to act together with other licensees to consult with appropriate representatives of the employees for the purpose of establishing and maintaining an appropriate machinery or forum for the joint consideration of matters of mutual concern in respect of the health and safety of persons employed by those licensees."

In order to comply with this Licence requirement, the privatised companies agreed to a continuation of the National Health and Safety Advisory Committee (HESAC), to which reference has been made Section 5.3.3. The representation on the National HESAC from management and the Trade unions is much the same as before but the management representatives have emphasised, at every opportunity, the independent responsibilities of the individual privatised Companies in matters of health and safety and the prerogative of those Companies to consult individually with the Trade Unions on such matters. In the privatised environment, the management side of HESAC has had no intention of even making "recommendations" to the privatised Companies. Before privatisation, national HESAC recommendations were often made (e.g. Codes of Practice on COSHH and Asbestos, Model Inquiry Procedures, Recommendations on the use of Ladders in Substations with Exposed Conductors). Although such Recommendations were not binding upon the ESI organisations, they carried an authority which was difficult for any organisation to resist and they were almost always accepted throughout the ESI.

The National HESAC in the post-privatisation environment, was no longer a forum through which the Trade Unions could exert any significant influence. This changed environment was difficult for National Trade Unions to accept, especially after having fought hard to retain the principle of National Consultation in the Licence Conditions. National HESAC meetings were difficult and acrimonious until the Trade Unions adjusted to the new situation. The changed nature of the ESI from a corporatist style, to an environment which emphasised the independence of the Companies, as well as the loss of Trade Union influence at National Level, is exemplified by these changes in the National HESAC arrangements. Prior to ESI privatisation, pledges were made by Government Ministers and by Industry leaders, that safety would not be allowed to suffer.

6.1.8 Management Co-operation

The lead Director for Health and Safety, within the Electricity Council, Jim Porteous, Chairman of Yorkshire Electricity Board, drew up arrangements for management co-operation on matters of Health and Safety (Porteous, 1990). These arrangements were agreed by the Board of the Electricity Association and came into effect upon privatisation. The two main bodies to be established were:

1. The Safety Management Co-ordinating Committee (Transmission and Distribution) (SMCC).
2. The Generation Safety Management Group (GSMG).

Senior Management Representatives of the Distribution, Transmission and Generation interests served on the respective groups. The Head of the Electricity Association Safety Group also served on the bodies and provided the secretariat. National Grid was represented on both bodies since NGC had both a Transmission and a Generation Licence. These bodies became very effective in dealing with safety matters of mutual interest such as in presenting a united and influential Electricity Supply Industry voice on HSC Consultative Documents and on HSE enforcement policy.

Before privatisation, arrangements for the national management co-ordination of Health and Safety matters had been led by the Electricity Council and Chaired by the Electricity Council's Chief Safety Officer. The Electricity Council had some ill-defined federal authority over the ESI Organisations but inevitably the senior management of those organisations tended to resist any attempt by the Electricity Council to exert its authority. Such political differences at the top of the ESI, particularly between the CEGB and the Electricity Council, were often reflected in relationships lower down and consequently the former arrangements for the co-ordination of health and safety matters by the Electricity Council were not always marked by an entirely co-operative spirit.

The new arrangements however, were established without ambiguity. The former Electricity Council was now the Electricity Association, "without views of its own". It became a Trade Association, employed by the ESI Companies to do only those tasks for which they were prepared to pay and it had no federal authority. The new bodies were chaired by ESI Company Representatives rather than by the Electricity Association, who now provided the secretariat. The level of co-operation within the new arrangements was markedly improved and no longer bedevilled by political differences.

6.1.9 Summary

In summary, the external environment for NGC and for PSB, post privatisation, was very different from the pre-1989 environment. The structure and ownership of the industry was totally different and in the aftermath of the expiry of the Golden Share,

Table 6.1 External Environment 1989 – Present

Forces and Expectations	Pressure Points
<ul style="list-style-type: none"> ▪ "Freedom" from direct Government control ▪ New ESI Structure -(Transmission function separated from Generation) ▪ Ownership of NGC by RECs -(Floated PLC's) ▪ Shareholders profit growth expectations ▪ City cost/headcount reduction expectations ▪ Market pressures /competition ▪ Pool operators real time demands on GENCOs ▪ Competition between GENCOs ▪ Risk exposure - commercial threats ▪ Instability of market ▪ Lack of certainty with respect to future ▪ Opportunities for profitable commercial activity ▪ Regulator overview of trading activity ▪ Regulator control of prices on monopoly activity ▪ No obligation to supply - market forces rule ▪ Exposure to international competition on overseas expansion ▪ Environmental concerns ▪ In the focus of enforcing authorities ▪ Still in public "political" arena ▪ Further commercial and political pressures surrounding potential flotation of NGC ▪ Pressure from Regulator to de-merge PSB from NGC and from RECs) ▪ Ending of Golden Share protection resulting in take-overs and mergers ▪ De-merger of PSB from NGC and trade sale ▪ Purchase of PSB by Mission Energy ▪ Flotation of NGC on stock market 	<ul style="list-style-type: none"> ▪ RECs ▪ City Institutions ▪ Government ▪ Political Parties ▪ Regulator (OFFER) ▪ Competitor GENCOs ▪ International competitors/partners/investors ▪ Public ▪ Pressure Groups ▪ Enforcing Authorities ▪ Trade Unions

take-overs have changed the Industry in directions and at a pace which could not have been predicted. Stability and continuity has been replaced by uncertainty and change. Market forces have replaced the "obligation to supply" and in the generating market, a low risk commercial environment has become high risk.

The corporatist approach has changed to one which emphasises the individual autonomy of the new Companies. The environment is freer in relation to seeking new business opportunities but the Regulator exercises a considerable power in fixing a price cap in monopoly situations and in overseeing competition in other situations. This influence together with City Institution, shareholder and peer pressure, has resulted in severe cost cutting targets which can only be achieved by competitive downsizing and outsourcing.

The strong Trade Union influence is now much weaker in negotiations and in consultative arrangements at national level on health and safety. The Electricity Council with its federal authority has been replaced by a very much smaller trade association with no authority of its own. New arrangements for management co-ordination on health and safety are in place and are working in a greater spirit of co-operation than previous arrangements.

Table 6.1 lists the elements characterising the external forces, pressures and expectations, relevant to and interacting with, NGC and PSB. The table also identifies the pressure points through which these elements are focused.

6.2 Structural and Cultural Change within NGC⁵

6.2.1 Introduction

The emergence of the National Grid Company plc, in 1990, as a wholly owned subsidiary of the newly floated RECs, has been noted in Section 4.3. The organisation was actually formed over a period of 12 months from April 1989, when the National Grid Division of the CEGB was created during the division of the CEGB's assets leading up to privatisation. All the Executive Directors of NGC were previous long serving ESI employees, as were almost all the original NGC staff. From these facts

⁵ During the period covered by section 6.2, the author of this thesis was the Safety Advisor to NGC and the Manager of the NGC Health and Safety Branch.

alone it may be reasonably assumed that the original Organisational Culture and Safety Culture of NGC, was that of the CEGB.

6.2.2 Initial Steps

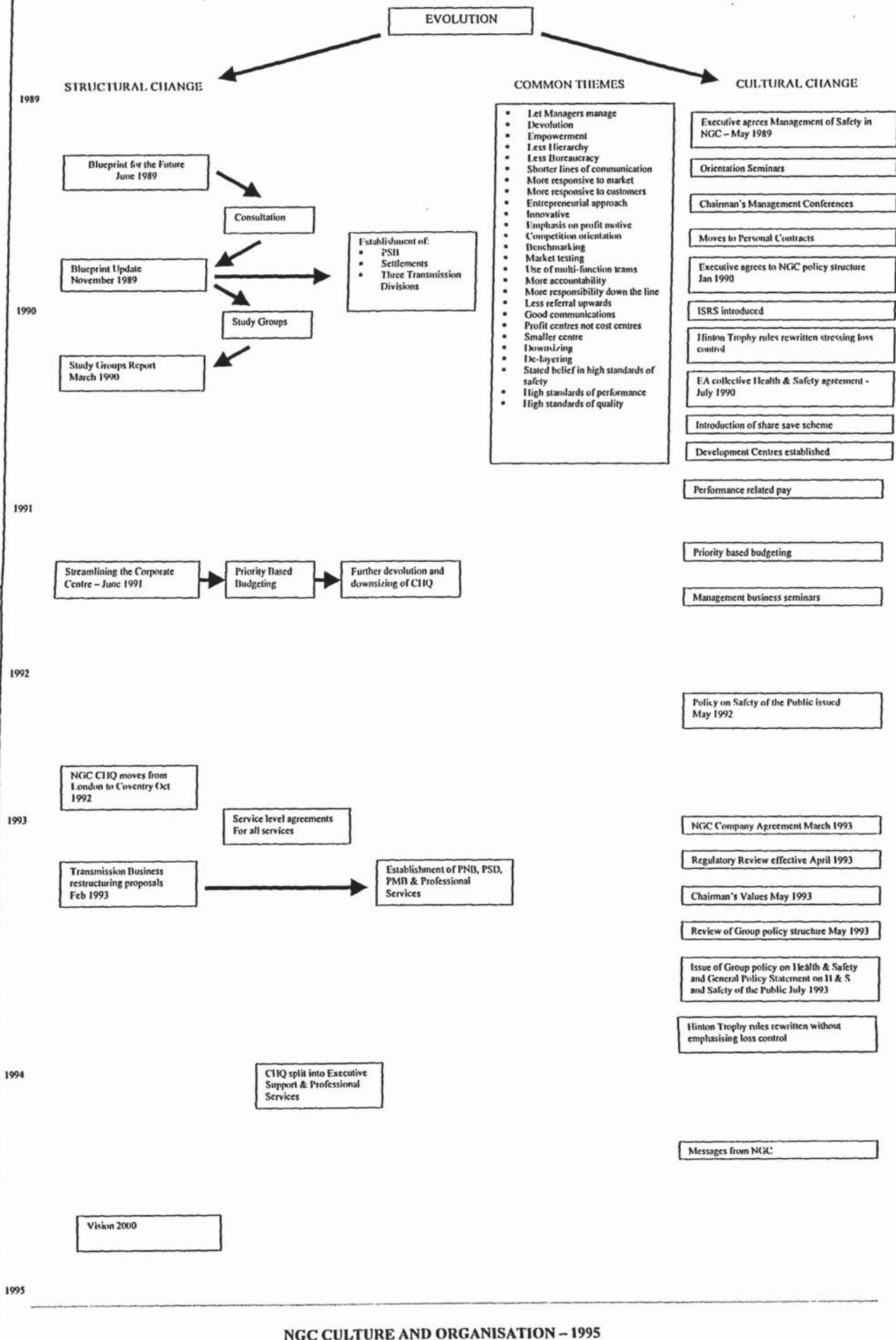
In response to the changed environment and circumstances outlined in Section 6.1, NGC began an internal organisational evolution and expressed an intention to achieve a change of culture. This progression is illustrated in Figure 7. The internal structure of NGC was modified following each of a series of organisational reviews. The structural changes are indicated down the left of the diagram. At the same time there were a series of identifiable initiatives which were non-structural changes. These are indicated down the right of the diagram.

It is acknowledged that organisational change can itself be an influence for cultural change and indeed, organisational change which forces permanent changes in behaviour, is almost certainly likely to be a more potent force for change than any amount of exhortation. The two influence streams are therefore, to a large degree, inter-dependant. Some of the structural changes were designed to produce changes in internal and external relationships, behaviours and expectations and were therefore specifically intended to promote cultural change.

During the first two years of the existence of NGC, a number of conferences were arranged at which the Chairman and other senior staff addressed all the managers of NGC. Such meetings were intended to encourage a sense of identity, direction and commitment as well as imparting information on the issues facing the new Company and the views of the Board of NGC on those issues. In addition, a series of seminars were held for managers ("Orientation Seminars"), designed to impart knowledge and understanding of the changed commercial aspects of NGC's activities and the view of the new accounting, business plan and budgetary requirements. A number of managers commented at the time that they were "*being sent away to be re-programmed.*" It is clear that this was an early but crude attempt to introduce cultural change amongst a key group of staff. It should be noted that the group represented the most successful five percent of their generation within the workforce, to have evolved within the CEGB culture. Many of them expressed the view that the content and style of the seminars carried the implication that everything they had done before was wrong and belittled the

CEGB CULTURE AND ORGANISATION – PRE-1989

Time line not to scale



NGC CULTURE AND ORGANISATION – 1995

Figure 7: Evolution of Culture – CEGB 1989 to NGC 1995

values they had held. A sense of resentment was privately expressed by many and openly expressed by one manager who was close to retirement. It is therefore questionable if these seminars were entirely well founded but they were probably based on a functionalist world view of culture change.

6.2.3 *Blueprint for the Future*

In June 1989 NGC produced *A Blueprint for the Future*, which was the first document to attempt to outline the shape of the future organisation and the cultural changes envisaged as being desirable and necessary. The document was produced for consultation with managers and staff and led to the production of a revised document, *Blueprint Update*, in November 1989. The June Blueprint document was aimed at proposing an organisational structure which met the requirements of the Transmission and Generation Licences and;

“the need to operate commercially in a competitive world.”

It proposed that the various activities in which NGC was engaged, should be run as separate *businesses*, both to meet the Licence conditions of ensuring accounts were *ring fenced* to avoid market distortions and cross-subsidies and to ensure confidentiality and integrity as well as to promote clear lines of managerial responsibility and accountability.

Four main businesses were identified:

- The Transmission Business
- The Agency and Contracts Business (including contracting and maintenance for other organisations)
- The Settlement Business (The Pool)
- The Pumped Storage Business.

It was acknowledged that other Businesses may be identified as time went on.

The overriding concern dealt with by the Blueprint was set out in the foreword by the Chief Executive:

- “All the Board members are determined to create an environment in which managers manage.
- Gone are the days when decision making is on the basis of referral upwards.
- Managers will be expected to run their own units and be accountable for their decisions.”

6.2.4 The NGC Mission

At the same time the Company Objectives - The NGC Mission, was identified and summarised in the following terms:

“Security of Supply

To operate and develop the high voltage transmission system so that secure and economic transfers of electricity can be made from generators to distributors, thereby allowing the latter companies to fulfil their obligations to satisfy consumers' demands.

Competition

To facilitate competition in the generation and supply of electricity by allowing licensed electricity operators to use the transmission system without discrimination.

Profitability

To earn a profit for the company's shareholders within regulatory limits, from the use of the transmission system and other business activities.

Control of the System

To control the bulk supply of electricity so that demand is met as cheaply as possible whilst maintaining the quality of supply within strict limits; this includes taking all reasonable steps to maintain supply when the system is under threat. The performance of this role will be governed by what is set out in the Grid Code but will include the calling up of generating plant in merit order and the economic planning associated with generation and transmission outages.

Confidentiality

To act with integrity in the possession of commercial information so as to ensure that neither the company nor any other person obtains any unfair commercial advantage from it.

Settlement

To calculate the payments to be made and received by the distributors and generators for the supply of energy.

Social Responsibility

To carry out all the company's responsibilities with due care for the environment and safety of people and plant”.

It is not the purpose of this analysis to examine the structural proposals in detail but to identify the motivation and cultural direction behind them. The *Blueprint for the Future* however proposed the establishment of the Pumped Storage Business, the Settlement Business (effectively the Pool) and the Transmission Business. The first two were to be stand-alone businesses and are self-explanatory in scope.

What was proposed for the Transmission Business (the core business of NGC and responsible for the bulk of its income), was that the existing single Transmission Division should be split into three managed Divisions, North, Central and South, each with a Divisional General Manager responsible to the Board. The General Managers would be responsible for all construction, operation and maintenance activities within their respective Divisions, as well as the management of the Grid System Control Centres within their geographical area. (Following the consultation process, the proposal to include the management of Grid Control Centres within Divisional General

Managers responsibility was deleted from the revised Blueprint Update, issued in November 1989.)

The cultural themes propounded in the Blueprint were to establish a flexible organisation, responsive to market and customer demands and the creation of a climate fostering enterprise, enthusiasm and the maximum commitment of staff to the success of NGC. This was to be achieved by developing work and authority as far as practical and streamlining management structures so that;

“reporting lines are short and individual accountability correspondingly enhanced.”

The emphasis was to be on;

“strong general management leading relatively small and where appropriate, multi-functional teams, each with a sharpened accountability for performance and the achievement of specified business objectives.”

This was intended to lead to reductions in staff, as well as in the number of line managers but to produce significant enhancement of the individual’s role:

- “operating across a wider span of activities with corresponding increase in experience and job satisfaction“
- “greater freedom to apply the principles of good management”
- “greater accountability and rewarded on the basis of their personal performance.”

Managed units were to be profit centres, not cost centres demanding a “new mix of skills” integrating the ability to balance the contradictory interests of the market place, the ability to meet the requirements of the Grid Licence and the Grid Code and the skills necessary to assess statutory, technical and operational requirements, the state of plant and business opportunities. The prospect envisaged was for “a more challenging and stimulating working environment.”

The main priority and thrust of the *Blueprint* was on the establishment of the Businesses and it was acknowledged that a further review would be required to consider in detail the role and structure of the Corporate centre. Nevertheless the *Blueprint* emphasised that with the devolution of accountability to general management, the Corporate Headquarters could be smaller and more streamlined and housing only those involved in policy development and corporate specialisms.

The NGC Headquarters was to be moved from the inherited CEGB premises, Bankside House, London, to a new building under construction near Coventry. This move, it was

suggested, would be an important catalyst in bringing about the change to the new organisation.

It was further envisaged within the *Blueprint*, that once the new Divisional General Managers and the other General Managers were in place, they would themselves establish their organisational arrangements and set targets for the progressive reduction of resources of all types, in their respective Businesses. It was proposed that some Corporate Headquarters staff would be transferred to the Businesses, retaining functional direction from the centre on policy matters. One proposal within the *Blueprint* was that some safety and medical staff would be transferred to the Businesses from CHQ.

Following the consultation process, a *Blueprint Update* was issued in November 1989. The Update clarified and elaborated on some of the principles behind the original document but the only substantial changes were:

- 1 Modifications to some directors responsibilities
- 2 The omission of Grid Control Centres from Divisional General Managers' responsibilities
- 3 The acceptance (following representation from the Group Safety Adviser⁶), that the safety function, for reasons of independence and audit, would remain wholly corporate and no staff would be devolved to the Businesses

In order to take the devolution process further, study groups were established to identify in detail, what work should be performed corporately and what work should be performed in the Businesses. The establishment of the Businesses, in accordance with the proposals, moved forward rapidly.

Whereas the transmission function had previously been managed exclusively by ESI engineers the three Divisional General Managers who were appointed were:

An ex-CEGB engineer with long experience in Grid System Control - Stephen Riddington

An ex-CEGB accountant - Clare Phelan

A manager from the private sector - William Talford

Certain aspects of these appointments were significant. An external manager was appointed, although it was generally believed that there were suitable strong internal candidates and a female accountant was appointed into a totally male engineer dominated sphere. It is almost certain that this represented a calculated attempt to engineer a cultural change.

An important feature of the organisation was that the income from "Use of System Charges" (NGC's main source of income), was allocated to the Transmission Divisions. In other words, they were deemed to own the income generating assets. The corporate centre and other parts of NGC, without a direct source of income, were therefore dependent upon internal transfers of this income. This was a crucially important change in the nature of the relationships between the different parts of NGC. This represented the beginning of a customer/client type of relationship between those parts of NGC which were deemed, however artificially, to be income generating and all the other parts of the organisation. Corporate functions were therefore clearly identified as an overhead but so also for example, was Grid System Management, without which the Transmission Business could not operate. It should be noted that PSB was, in this respect a genuine income earner, independent of the rest of NGC and PSB too, was required to remit part of its income to support the Corporate overhead.

6.2.5 Personal Contracts and Performance Related Pay

In parallel with these organisational changes, performance related pay was introduced, initially for the directors and General Managers. Executive share options were also introduced. Personal contracts were introduced for new managers, recruited from outside the Company and all existing managers were encouraged to change to personal contracts instead of being represented on the National Managerial Negotiating machinery. The personal contracts included an element of annual performance-related bonus payment as well as a modest increase in salary as an inducement to change. The personal contracts for most managers were personal only in the sense that they applied to that individual and they were not negotiable. A reluctance to accept a personal contract could be taken as a lack of commitment and by early 1991, almost all senior managers were on personal contracts.

⁶ The author of this thesis.

6.3 The Initial Development of Health and Safety Culture within NGC

6.3.1 The Management of Safety in NGC

In March 1989, a paper on the Management of Safety in NGC, prepared by the Group Safety Adviser⁷, was accepted by the NGC Executive and was subsequently promulgated to all NGC managers by the Chief Executive (Kerss, 1989). The paper confirmed NGC's Determination to strive to achieve and maintain excellent safety standards and to allow no deterioration in standards. It emphasised that NGC would regard safety performance as equal in importance to the other primary objectives of the Company and that safety was a line management function, for which managers would be accountable for meeting specific targets. The Safety Branch was charged with providing a comprehensive safety advisory service to the Company and was also encouraged to earn revenue by selling its expertise externally where appropriate.

6.3.2 NGC Safety Policy and Guidance

NGC issued its statutory Health and Safety Policy Statement (NGC, 1990) with a covering statement signed by the Chairman, confirming that safety performance ranked equally in importance with the other primary objectives of the Company and in April 1990, a Guidance for Managers on the Management of Safety document (NGC, 1990a), was launched by the Chief Executive, at a conference of all NGC managers. This document emphasised the corporate stance and provided practical advice to managers against all the points covered in the Statutory Policy Statement.

In accordance with the cultural direction of the Company, the Executive provided instruction in January 1990 (Drew, 1990), on the structure of policy within the Company. Policy issued from the centre was to be minimal in scope and restricted to those aspects where central direction was unavoidable. Otherwise the centre should issue guidance in the form of "Model Business Procedures". All safety policy and guidance was issued to meet these criteria. The former Transmission Division had issued Transmission District Instructions (TDI's) from the centre, to all management units. These were detailed mandatory instructions supporting the Safety Rules. The NGC Safety Branch redrafted and re-issued all TDI's in the form of Codes of Practice,

⁷ The author of this thesis.

which were Model Business Procedures. The Area Managers then had to convert the Model Business Procedures back into mandatory instructions issued by themselves. They protested about this development and were unsympathetic to the change. They believed that for important safety procedural documents, it was preferable to receive a centrally produced procedure which could be applied similarly throughout the company. In the end the Area Managers reluctantly accepted the inevitability of the centre issuing guidance, rather than direction and the Directors' view therefore prevailed.

6.3.3 Inter-Company Co-operation on Health and Safety

In January 1990 the Board of the Electricity Association agreed the structure of the arrangements for dealing with matters of collective concern on health and safety. See Section 6.1.6, (Porteous, 1990).

The company representatives on the Generation Safety Managers Group were anxious to establish inter-company co-operation on the exchange of essential safety information. Knowledge of a transformer explosion in one company could be vital in preventing a serious accident in another company with the same type of transformer. At the same time, the knowledge that a major plant item was out of service could be commercially useful to other companies. Senior safety managers no longer felt confident about exchanging information in a climate where commercial confidentiality and intellectual property rights were being stressed continually. In spite of the pledges of co-operation on safety issues, it was clear that the aggressively independent stances of the newly formed Companies was going to make information exchange difficult unless the highest authority was first obtained.

It was initially proposed that the ex-CEGB Companies should participate in existing information exchange schemes, which were used by the RECs but this was rejected by the NGC Executive as too bureaucratic. A subsequent proposal establishing a simple set of principles for the exchange of such information, was accepted and a letter from the Chief Executive of NGC secured the agreement of his fellow Chief Executives in the other Generating Companies, to these principles. These examples serve to illustrate the effect of the cultural changes on the Safety function within the ESI.

6.3.4 The Conflict Between Objective Setting and Prescription

The Executive Directors were clearly opposed to direction from the Centre and were strongly opposed to any suggestion of bureaucracy. At the same time the examples illustrate the degree to which Companies were sensitive to exchange of information and how the Location Managers in NGC were more in favour of a pragmatic approach than a philosophical approach. The NGC Corporate Safety Branch responded by underlining its advisory and support role and emphasising the responsibility of line management for managing safety and the integration of safety with all other line management concerns, responsibilities and targets. Policy *guidance* was issued from the centre rather than policy *instruction*. The guidance was made as flexible and as non-prescriptive as possible.

This approach was pursued rigorously although it occasionally led to difficulties. For example, advice was issued in relation to the fitting of earths to overhead lines either by contractors' staff or by NGC staff. A range of options was provided, all of which complied with the Safety Rules but at the same time allowed the different Transmission Divisions to follow their preferred practice. The contractors protested that they were having to follow different practices in different parts of NGC thereby increasing the risk of a mistake with serious consequences.

Another issue which exemplified the problems associated with the devolution of authority was the need to arrive at a common terminology for the purposes of agreeing electrical isolation across control boundaries with RECs and GENCOs. Here there is no room for misunderstanding or error and understandably the GENCOs, who had power station control boundaries within each of the five NGC Control Areas, were seeking common terminology nationally. Pre-privatisation, the South West Region of the CEGB, for example, would have agreed with the Area Boards in its territory, on the language to be used and the North West Region would have agreed with its Area Boards on a somewhat different language. This did not matter as long as the individual language conventions were only being used within specific areas and between the same parties. Post-privatisation the GENCOs were national organisations with power stations in each of the former CEGB Regions. They naturally wanted to train their staff to a common standard. These differences were inherited in the post-privatisation situation and it was essential, under the Grid Code arrangements, to arrive at a common

understanding. This meant changing some long established conventions. This was difficult to achieve against a background in which the devolution of authority was continuously being emphasised. The chief opposition was from within the NGC Control Areas and their respective NGC Transmission Areas.

A common language for inter-boundary working was finally achieved.

6.3.5 The Introduction of an Audit System

Another action taken by the NGC Safety Branch to meet the new cultural norms of NGC, was to propose to the Executive that NGC should adopt the International Safety Rating System (ISRS). This was seen as providing a formalised approach that would assist line management in the management of safety but it also fitted well with the cultural themes being pursued.

ISRS provided an objective audit system which could therefore be linked to quantifiable *performance targets*. This in turn, could be an aid to *benchmarking* with external bodies since the system was very widely used. It required the setting of *performance standards* and the placing of clear *responsibility* and *accountability*. The most significant feature was that ISRS was based on the control of avoidable loss and emphasised the managerial linkage between losses to people, plant and process. In NGC terms losses to people were regarded as being under reasonable control, at least as far as the major hazard was concerned, high voltage electricity. A number of incidents involving loss of supplies to major customers and to parts of the Grid System and accidental losses of grid transformers, (approximately £5M each), emphasised the overriding importance of plant and process losses to NGC. Since any such losses represent direct loss of profit, the use of the ISRS approach should make a major contribution to profitability by controlling avoidable loss (then estimated as being, at least, between £12M and £20M per year).

The Executive of NGC declined to underwrite the adoption of ISRS in NGC but agreed that General Managers should be free to introduce ISRS if they chose to do so. By 1993, the ISRS approach was adopted throughout the Transmission Business and the Grid Control System as well as at most other non-operational locations. This was, in every case, at the request of the location manager. (PSB did not adopt ISRS until 1994 and were one of the last management units to do so). The Directors were therefore true

to their policy of not imposing the system upon the Businesses and the system was therefore adopted solely by the commitment of location managers.

6.3.6 Board of Inquiry Procedures

The CEGB Board of Inquiry procedures have been referred to in Section 4.5.6. NGC initially adopted those procedures but there was growing pressure from legal advisors, with no previous experience of the Industry, suggesting that the Inquiry procedure and particularly the Inquiry reports, which were discoverable documents could put the company at disadvantage in any subsequent litigation. There was even a suggestion that the procedure should be dropped altogether. These pressures were successfully resisted but the procedures were changed by the Directors, so that the Board of Inquiry was empowered only to produce a factual report and must not produce recommendations, which could make the Company a hostage to fortune.

6.3.7 The Re-organisation of the Corporate Centre.

Following the report of a Blueprint Study Group (NGC 1990b), the NGC Executive approved "Streamlining the Corporate Centre - A Blueprint for the Management and Organisation of Central Activities" This Blueprint was published in June 1991 (NGC, 1991). The philosophical basis of the Blueprint was based on :

"The Need for Greater Devolution - seen as a major catalyst for release of latent energies, generation of enthusiasm, speed of decision making and commercial thinking at all levels. Maximising these benefits meant looking for opportunities to devolve activities beyond that already envisaged.

A New role for the Centre - focusing on giving policy direction in strategic areas and developing and setting targets to help Directors to assess performance but taking a much lighter role in detailed planning, guidance and co-ordination of business matters.

New ways of Working - breaking down hierarchical barriers to efficiency and extending multi-functional working and team working re-orientating the role of the manager at the centre from being the controller and supervisor of dedicated resources to becoming the providing of specialist resources for use by the company as a whole.

A New Approach to Manpower - minimising central overheads by setting numbers at the centre in strict proportion to total NGC manpower enabling managers in the businesses to see their own efforts to minimise staff costs reflected in proportionate reductions at the centre."

It was recognised that the Centre comprises "The Corporate Team" the function of which is truly to support the Directors in essential decision and policy issues and "The Central Business Teams," whose work is undertaken centrally but exist primarily to support the various Businesses. The objective on which the Blueprint proposals were based was stated as follows (taken from the 1991 Business Plan): (NGC, 1991b)

“To ensure that the company achieves levels of profits which permit dividends to be paid in line with the policy set out in 1990/91 Business Plan and finance the costs which arise from NGC fulfilling its Licence requirements.”

This objective contrasts rather starkly with the much more expansive and socially conscious objectives set out in the 1989 Blueprint (see section 6.2.4).

The 1991 Blueprint proposed that the objective of all central teams should be to maximise their contribution to the objective and that:

- *“only those tasks necessary for the achievement of the primary objective are carried out, and*
- *ensuring that those tasks which are necessary are resourced and carried out in the most cost effective way”*

This was to be achieved by requiring all Corporate teams to secure financial sponsorship for their activities, either from the Executive or from the Businesses. The mechanism proposed to determine the existence of sponsorship was Priority Based Budgeting (PBB). The services provided by each team were to be identified and the customers also identified. A review panel, chaired by a senior manager, would then determine what level of service they would support.

As a result of this process further devolution of central activities and more downsizing took place. The total headcount levels of NGC (March end figures) from 1989 to 1995 (estimated) are given in Table 6.2 below. The comparative figures for PSB are also stated. The Safety Branch lost one of its eight engineers as a result of the headcount reduction requirements.

Table 6.2 Headcount levels (March end) for NGC and PSB:

End March	NGC	PSB
1989	6283	160
1990	6514	188
1991	6537	188
1992	5903	188
1993	5318	192
1994	4682	192
1995	4251	195

The Safety Branch had been attempting to build an entrepreneurial activity by selling its skills externally as required by the paper approved by the Executive in May 1989. Some work had already been carried out for Northern Ireland Electricity and more had been requested. The Chief Executive indicated in 1991, that if the Branch was pursuing external work it had too many resources. The entrepreneurial activity of the Branch, for which considerable enthusiasm had been generated, then ceased.

6.3.8 NGC Company Agreement

Following long negotiations, the Trade Unions and NGC signed a new Company Agreement in March 1993 to replace all previously nationally-negotiated agreements. This meant that NGC was no longer constrained by the need to abide by undertakings arrived at with the involvement of the other ESI Companies. The Company Agreement covered both negotiating and consultative arrangements including health and safety. It also was a "single table agreement" thus eliminating the multitude of separate bodies at Local, Company and National level which dealt individually with each different negotiating group. It created a single common pay spine. All existing staff, of whatever group, were to be assimilated to a point on the single spine. At the same time new bodies were established to deal locally (Local Councils) and at Company level (the Company Council), negotiating matters and Local HESACs and Company HESACs to deal with health and safety matters.

6.3.9 Regulatory Review

The importance of the impact of regulatory review must be recognised. The Regulator, Professor Littlechild, set a new price cap of RPI-3% for each of the next four years from April 1993, for Transmission charges. This externally imposed downward pressure on prices, provided the most potent driver to reduce costs and the greatest part of that cost reduction was necessarily to focus on staff reductions.

6.3.10 Transmission Business Restructuring

In March 1993 NGC announced the restructuring of the Transmission Business. (NGC, 1994). This represented a further evolution in thinking, in which the Grid system assets were to be owned by the Power Network Business, which now included Grid System Management and all the Grid Control Centres. The construction and maintenance

activities which had previously been combined in the three Transmission Divisions were to be formed into the Project Management Business (Construction) and the Engineering Services Business (Maintenance). The latter was subsequently titled the Power Services Division. PMB and PSD would act as contractors to the owners of the assets PNB. Professional Services were identified, which would contract for work within (and outside) the National Grid Group (NGG), whilst other Professional Services, (mainly based at Headquarters), were identified as requiring further consideration.

6.3.11 Profit Centres and Service Level Agreements

It should be noted that Corporate Health and Safety was included within "Personnel". This structure finally established within NGC, a series of Businesses and Services in which the business and service functions were to provide their services under contract, in a customer client relationship. Every activity would have a price and a customer prepared to pay that price. The contracts or Service Level Agreements (SLAs) were to specify the nature and standards of the service, the price and the basis of payment. In the case of the Safety function, SLAs had to be established with every part of NGC. This represented a major cultural shift in that the Safety service was no longer something which was imposed as an Executive requirement but began to be something which was purchased and to the extent that choice was allowed, may or may not be taken up.

The structure therefore established an internal market and placed the bulk of NGC's staff in the role of contractors to other parts of the company, with the knowledge that the service could be purchased elsewhere if such were the business judgement. The structure also established the possibility of a large component of the Company (PSD say), being floated as a separate Company or subsidiary.

6.3.12 The Chairman's Objectives and Values

In May 1993 the Chairman brought all the NGC senior managers together to announce his Objectives and Values. (NGG Chairman, 1993).

In essence these were as shown in Table 6.3:

Table 6.3 Chairman's Objectives and Values

NGC's Objectives	NGC's Values
Provide the best quality of service Deliver reasonable returns to share holders Develop and empower staff Build a team based organisation Develop business through partnership Forge closer links with suppliers Create new business opportunities Be at the forefront of best practices world-wide Facilitate even handed competition	Support for personal development Commitment to the highest standard of service Recognition of individual contribution Safe working environment and reliable service Open communications and mutual trust A cleaner healthier safer environment Partnerships with local Communities Professional and ethical business conduct

It is worth noting that the final draft of the Objectives and Values contained no reference at all to health and safety. Representations by the NGC Safety Adviser alerted the Chairman to this fact and a reference was subsequently inserted in the published version in time for the formal launch. A real danger of such initiatives is that the experience of many staff, who have seen so many initiatives before, is that they tend to be a nine-day wonder (Turner et al., 1989). The likelihood is that staff start off by being sceptical and look for the first sign of hypocrisy in those propounding the values.

6.3.13 Headquarters Professional Services

In January 1994, the CHQ based professional services were divided into an Executive Support Group and Professional Services Business Teams. This included the health and safety function. One individual was appointed as Health and Safety Policy Manager within the Executive Support Group. The Health and Safety Branch staff were substantially reduced in number and one of them was appointed as the Business Manager of the Health and Safety Professional Team.

Service Level Agreements were now required between the Health and Safety Team and all the other groups within NGC, including the Health and Safety Policy Manager in Executive Support.

6.3.14 Hinton Trophy

The Hinton Trophy (see Section 4.5.7), had been inherited by NGC and soon after privatisation, the Chairman of NGC asked for judging criteria to be written appropriate to the new company structure. This was done and the criteria retained a strong emphasis on safety and loss control. By 1994, the Hinton Trophy criteria had been re-written again, with safety criteria no longer emphasised. The Grid newspaper reported the award of the Hinton Trophy in 1994 with no reference to safety at all. (It may also be noted that the NGC Annual Report for 1993/94 contained no reference to safety. All previous Annual Reports had contained such a reference.)

6.3.15 Vision 2000

In October 1994 NGC published Vision 2000 which set out proposals for the phased closure of four Grid Control Centres leaving all remaining Grid Control functions to be carried out from the National Control Centre at Wokingham.

6.3.16 Messages from NGC

During 1994, an external consultant was engaged by NGC to research internal communications within NGC (Lowe & Carrington, 1994). Although the survey was ostensibly about communications, the findings collated views on business autonomy, restructuring, downsizing, views on management, morale and motivation, communications and lessons for the future. The report was presented largely in the form of verbatim comments from respondents of which the following comments provide a flavour:

On business autonomy there was a general feeling that each business operated as a separate entity. Staff worked for their businesses, not NGC. NGC was irrelevant, each part was working at reinventing the wheel and information was a tool in the defensive sniping from behind Chinese walls. Most people did not understand the purpose of restructuring NGC and had difficulty in understanding the part of the business to which they belonged. Constant change was resented and it was interpreted as a means to achieve a headcount target and was being thought out as it was being implemented. Some thought it was a case of change for the sake of change and the Directors did not know what they were doing.

People were resentful at having to move house constantly and one person who had complained of a third move had been told to move or quit. The comments on downsizing were mainly focused on what was thought to be the arbitrary and unfair way it had been implemented. People who had no job in the new structures were referred to officially as “transitional staff” and more colloquially as “leper colonies”. Voluntary redundancy was increasingly seen as constructive dismissal. Many of the experts had gone and the opportunity to provide “death with dignity” had misfired.

On management, staff generally identified with their immediate boss but senior management was seen as remote. Morale was said not to have been a problem in the days of keeping the lights on but now the prevailing view was that contributions were unrecognised and attitudes ranged from cynicism to fear and anger. What was reported by the researcher to have been lost was easy networking, trust, commitment, service concept and motivation. One of the reasons suggested for this was the engineering led culture in which man management is found difficult.

On communication people were drowning under excessive paperwork but did not have the information they needed, described by the researcher as *paper overload, information void*. Local communications were highly trusted and appreciated and the Company newspaper, The Grid, was successful in reaching everybody. Meetings were generally seen to be infrequent and poorly managed with staff expressing the view that it was best not to put your head above the parapet.

It must be noted that the situation in PSB was very much better than the rest of NGC in this survey.

6.3.17 Summary

By 1995, the year in which PSB was de-merged, NGC had evolved very significantly, in both organisational and cultural terms, from its starting point in 1989.

In response to the changing external environment, its own internal organisation was transformed into a series of Businesses and Services which traded internally, based on contractual agreements. Every activity had a price and a customer.

It had broken away from its corporatist past, at least in respect of the National Industry Agreements and associated bureaucracy. It was entirely responsible for its own relationships with its staff on matters of terms and conditions. Most of its senior staff were on personal contracts and performance-related pay was extending to all levels of staff, many of whom were participants in share-save schemes.

Downsizing had begun to take effect and the total headcount figures for NGC had fallen from 6,283 in 1989 to 4,251 by March 1995. Table 6.4 lists the elements characterising the cultural values which NGC sought to embrace by 1995:

Table 6.4 Cultural Values Which NGC Sought to Embrace
<p>"Let Managers manage"</p> <p>Devolution of authority</p> <p>Empowerment</p> <p>Less hierarchy</p> <p>Less bureaucracy</p> <p>Shorter lines of communication</p> <p>More responsive to the market</p> <p>More responsive to the customer</p> <p>Entrepreneurial approach</p> <p>Innovative</p> <p>Emphasis on the profit motive</p> <p>Competition oriented</p> <p>Benchmarking</p> <p>Market testing</p> <p>Use of multi-functional teams</p> <p>More accountability</p> <p>More responsibility down the line</p> <p>Less referral upwards</p> <p>Good communications</p> <p>Profit centres not cost centres</p> <p>Smaller Corporate centre</p> <p>Downsizing</p> <p>De-layering</p> <p>High standards of safety</p> <p>High standards of performance</p> <p>High standards of quality</p>

The Objectives and Values set out by the Chairman were as stated in Section 5.3.11.

The primary objective of the Company as set out in the Corporate Blueprint has been quoted in Section 5.4.6 but it is worth restating:

"To ensure that the company achieves levels of profits which permit dividends to be paid in line with the policy set out in 1990/91 Business Plan and finance the costs which arise from NGC fulfilling its Licence requirements."

If any CEEB employee, at any level, had been asked why the CEEB existed, it is inconceivable that they would have responded in terms remotely similar to that objective.

6.4 Update on Cultural Issues in NGC - December 1995

Although not directly relevant to the continuing evolution of the PSB culture, the fate of some of the recently introduced changes in NGC provide an interesting commentary on the factors which may or may not influence the evolution of organisational culture.

In December 1995 it was reported that the Chairman's Values were "*rarely mentioned*" ... and had "*sunk without trace.*" There was a new emphasis on "*NGC being run as one company...one NGC.*" This was a marked reversal of the earlier emphasis on promoting the independence of separate business units. More than 10% of employees were agency staff, including some in positions of influence. Concern had been expressed that there were so many people with "*no commitment to the Company.*"

The Safety Branch was no longer required to establish service level agreements and was once more restored to the position of a corporate overhead which had to be accepted by the businesses.

6.5 So Had the Culture Changed?

Without any objective data, it would be wrong to assert the extent to which any real cultural change had taken place in respect of the basic underlying beliefs and attitudes of the bulk of NGC staff. The Chairman and Directors repeatedly stated that they were seeking cultural change as indeed they were strongly motivated to do. They were leading the organisation and building a new company, even though they, like almost all the staff, had spent most, if not all, of their previous careers in the ESI. There can be no doubting the external motivation. Pressure from the City, shareholders, the Regulator as well as the peer pressure within the industry, to achieve profit growth whilst reducing prices in real terms, was formidable and necessitated changes.

Many of the actions taken to induce change are noted in this chapter and amount to attempts to bring about change by exhortation (e.g. re-orientation seminars, Chairman's Objectives and Values), or by structural organisational changes. These two approaches

could be respectively categorised as either attempting to influence behaviour directly, through exhortation or indirectly, through structural change.

The direct attempts to influence staff appeared to be at best ineffective and at worst, counterproductive, creating scepticism and cynicism.

The indirect attempts, via organisational change, were almost certainly much more successful. Organisational change, which imposes a new relationship, can force a change of behaviour. For example, creating an internal market produces a situation to which people have to respond and is seen to have a permanence which a high sounding management initiative does not possess. Against this it must be noted that the first major organisational change survived only for little more than two years before the next reorganisation affecting the same part of the business and several other changes were relatively short-lived. The Directors appeared to be feeling their way towards an optimum structure.

Another difficulty arises from the fact that one of the primary, if relatively understated objectives of reorganisation, was to reduce staff numbers. The staff in NGC was reduced by 33% between 1989 and 1995. This is likely to create a climate of mistrust and fear and sits uncomfortably with the altruistic statements about enhancing the role of the individual set out in the Blueprint for the Future (see section 6.2.4).

The communication survey referred to in section 6.3.16 above, provided a clear indication of uncertainty, mistrust and low morale. This indicates the difficulty of achieving cultural change at a time of major reorganisation and also serves to illustrate the futility of believing that cultural change can take place in a relatively short period of time.

Chapter 7

EVALUATION OF THE PSB SAFETY CULTURE

Part 1 – Methodology, Policy, Procedures

Custom reconciles us to everything.

Edmund Burke 1729-1797

7.1 Introduction

Chapters 3 to 6 describe the historical review phase of this research, the objective of which was to analyse and understand the nature and culture of the environment and organisation from which PSB had evolved. The next phase of the research was focused specifically on understanding the safety culture of PSB in the context of the events, influences and change to which it was being subjected. This Chapter details the methodology which was adopted for this phase of the research and contains an analysis of the safety philosophy, policy and procedures within which the safety culture of PSB exists.

7.2 Methodology

7.2.1 Overview

In order to gain an understanding of the safety culture of PSB and to meet the research objectives set out in section 1.3, it was recognised that the site work must include:

- Familiarisation with management, staff, business, organisation and locations
- Detailed individual discussions
- Structured interviews with selected individuals
- Critical analysis of business and location procedures
- Direct observation of conditions and work activities
- A view of the organisation from the perspective of the public (the power stations are open for guided public tours)
- Questionnaire development including validation
- Questionnaire distribution (first and second)
- Collation and analysis of data

- Discussion and review of findings against objectives
- Conclusions

7.2.2 Obtaining Agreement

A pre-requisite was to obtain the permission and co-operation of the management of PSB to the research programme. Initial discussion with the General Manager and subsequent individual discussions with all the senior management team confirmed that they would offer enthusiastic co-operation. At these discussions the objectives and methodology were explained and agreement was reached for free and open access to locations, documentation, management and staff. In order to obtain the wholehearted co-operation of the staff it was agreed that the author would make a presentation to the PSB HESAC and obtain their endorsement to the research project, prior to commencing site work. It was agreed that staff must be assured that the research was independent of the management of PSB and NGC, that all information provided by staff would be treated as confidential and that the anonymity of those who were interviewed or who responded to questionnaires, would be preserved. It was acknowledged that support would be strengthened if staff could see a useful outcome. It was agreed that the author would produce a report for PSB summarising the findings and that this report would be made available to the PSB HESAC. Finally it was agreed that the author would continue to liaise with PSB management on the procedural aspects of the research, such as the timing of the distribution of questionnaires, to avoid any unnecessary conflict with PSB initiatives.

The presentation to the PSB HESAC was made, the assurances were given and the endorsement of the HESAC was received. The author agreed to a HESAC request that they be kept informed of the progress of the research. The author contributed a brief description of the purpose and nature of the work in the PSB newsletter to all staff and specifically discussed the project with individual elected staff representatives at an early stage to ensure the co-operation and support of these opinion-formers. Some brief presentations were also given to small groups of staff to aid confidence building and to provide an opportunity to respond to questions from staff. It is considered that the care and attention devoted to the obtaining of agreement of all parties resulted in an excellent level of co-operation at all stages.

7.2.3 Data Collection

At a very early stage, the opportunity was taken to join a public tour at each of the power stations to obtain an insight from the perspective of a member of the public. This was undertaken incognito and unannounced and before the staff involved would recognise the researcher.

In view of the nature of the organisation, most of the data were gathered at the two power station sites. For this reason, the bulk of the site visits and discussions were concentrated initially, on Dinorwig and Ffestiniog. The exceptions to this were early discussions with both the Commercial Manager and the Business Development Manager at Bala House to obtain an overview of their responsibilities and the activities of their staffs and their relationships with the rest of PSB, with NGC and with other external interfaces.

During a series of visits to both Dinorwig and Ffestiniog sites, discussions were held with all individual members of the management team, all supervisors, most functional specialists and a broad sample of industrial, clerical and administrative staff. The purpose of these discussions was to obtain an understanding of individual roles as well as the working of the organisation and to begin to build up a qualitative picture of the beliefs, values and attitudes of management and staff. The opportunity was taken, during the visits, to observe work activity and to note general workplace conditions at each site. A number of meetings were attended to gain a further insight into the working of the organisation and relationships within PSB. These included daily morning meetings at both power stations, an engineering meeting, a PSB Executive meeting, HESAC meetings at each power station and a Local Council meeting. The structure and content of safety policy and procedures were considered to enable a judgement to be made in respect of quality and coverage and as essential background for site observations. Throughout the data gathering work described above, an underlying intention was to establish the status of PSB in relation to the statements in the ACSNI prompt-list. (Reproduced in Appendix D).

Based upon information obtained from relatively informal discussions, site observations, study of procedures and attendance at meetings, a number of individuals were selected for structured interviews, with the purpose of obtaining further data to

confirm or contradict information already obtained. As far as possible, the interviews were structured to obtain the views of the interviewees on the status of PSB in relation to the statements in the ACSNI prompt-list.

A questionnaire was prepared to seek further information in respect of the issues identified in the ACSNI prompt-list and also to provide additional data to confirm or contradict information already obtained. The development, validation and use of the safety culture questionnaire is described in detail in Chapter 9. The questionnaire was distributed for the first time in March 1995. The questionnaire responses were analysed and a report was prepared and presented to PSB as agreed, based on all the data collected.

It was intended to issue the questionnaire again after an interval of approximately two years. It was distributed again in February 1997. During the intervening period changes in the external context of PSB continued. Site visits continued between 1995 and 1997 and observations and discussions continued, although at a reduced level but with the objective of tracking events and changes. The observations based on this period are recorded in Chapter 10.

7.2.4 The Structure of the Site Studies

In effect, the site studies may be considered as comprising three stages:

1. Examination of policy and procedures, involving minimal personal interaction between the researcher and site staff.
2. Direct observation, informal discussion and structured interviews, involving considerable personal interaction between researcher and PSB staff.
3. Development and use of the safety culture questionnaire, involving some personal interaction between the researcher and PSB staff.

Although these are identified as three separate stages, this is a somewhat artificial distinction. Each stage informs the others and in practice, they overlap in time.

The consideration of the site studies within this thesis is structured under the following headings:

- ***Philosophy*** - The broad, high level approach to the management of safety in NGC and PSB - (Chapter 7)

- ***Policy*** - The principal policy statements detailing NGC company and PSB business, approach to the management of safety – (Chapter 7)
- ***Relevant legislation*** - The statutory requirements relevant to the management of safety in PSB – (Chapter 7)
- ***Management structure and responsibilities*** - The organisational structure and reporting relationships and accountabilities relevant to the management of safety in PSB – (Chapter 7)
- ***Design safety approach*** - Design features that set the basis of the cultural inheritance of PSB – (Chapter 7)
- ***Institutional arrangements relevant to the management of safety*** - The contribution and influence of meetings (regular and ad hoc, executive and consultative) and trade union safety representatives, to the management of safety – (Chapter 8)
- ***Procedures for the management of safety*** - The detailed procedures which are significant in the management of safety in PSB – (Chapter 8)
- ***Site observations*** - Working conditions, environment and working practices – (Chapter 8)
- ***Public safety*** - Arrangements for the safety of the public on PSB property – (Chapter 8)
- ***Safety performance*** - Performance targets and specific incidents – (Chapter 8)
- ***Other general issues*** - Personal performance targets, flotation, industrial relations issues, care and concern, education and training, communications, use of external consultants – (Chapter 8)
- ***Influence of the researcher*** - Effects of the researcher on the management of safety in PSB during the research – (Chapter 8)
- ***Development and USE of Safety Culture Questionnaire*** – Development, validation and distribution of questionnaire and analysis of responses – (Chapter 9)

The analysis under each heading includes factual data obtained during the investigation as well as comment on the data. The remainder of this Chapter comprises an examination of the policy and procedural background to safety in PSB.

7.3 Philosophy

7.3.1 The NGC Stated Philosophy

Throughout 1994 and 1995, PSB was part of NGC and was subject to NGC policy. It

Is therefore essential to examine the structure of safety policy in PSB in the context of NGC policy. When NGC was being established in 1989, the Chief Executive circulated a paper, (which had previously been endorsed by the Executive), to all managers on safety objectives of the Company, (NGC, 1990a) The paper stated:

"The Company will strive to achieve and maintain an excellent safety performance both in relation to the staff of the Company and others affected by its operations

....It will be the policy of NGC to regard safety performance as equal in importance to the other primary objectives of the Companyand

.... It is now and will remain, a fundamental part of every line manager's job, to ensure the provision of safe systems of work and that only adequately trained and competent staff are authorised to carry out work on behalf of the Company. Line managers will be accountable for meeting safety performance targets in the same way as any other management targets."

The statutory NGC Health and Safety Policy Statement was subsequently issued in 1990 (NGC, 1990), under the signature of the Chairman of NGC and was accompanied by his personal statement that:

"The National Grid Company is committed to achieving and maintaining excellent standards of health and safety. Performance in this area ranks equally in importance with the other primary objectives of the Company....."

When the NGC Management Guidance Document on The Management of Safety, (NGC, 1990a) was issued to all managers in 1990, the Chief Executive included the statement:

"....Strong positive management of the health and safety aspects of the Company's activities, is required at all times. The health and safety performance of the Company will be a product of the success of location managers, in reducing accidents and avoiding work related ill-health. Manager's achievements in this field will be judged on the same basis as achievements in relation to the other primary objectives of the Company."

When the Chairman's Objectives and Values were issued in 1993 (NGC, Chairman 1993), the Objectives included:

*"Be at the forefront of best practice world-wide....
We will remain at the forefront of the best practice we can find in the world. This includes our performance standards, our technology, our health and safety record, our service delivery and our cost-effectiveness in running the business."*

The Values included the statement:

"A safe working environment (is) bred into everything we do and

NGC takes into account the effect on the environment of all its actions in any country in which it operates and works to match rising public expectations of a cleaner, safer, healthier environment."

7.3.2 Comment on the Stated Philosophy

It is reasonable to assume that the high level public statements referred to above, set and directed the Company philosophy on safety and that the Company philosophy applied to PSB just as much as to the rest of the Company. The repeated high profile statements indicate that safety was not only very important to those at the head of the Company but that safety performance was just as important as the other primary objectives of the Company. Whilst there is no evidence on which to doubt the sincerity of those statements, the extent to which they are truly internalised and the depth of real commitment, is called into question by a number of factors:

- The Annual Report and Accounts of NGC for 1993/94 (46 pages), carries no reference to safety performance in spite of its being *of equal importance to the other primary objectives of the Company*. This omission, in 1993/94, follows the four previous Annual Reports, all of which carried a separate section commenting specifically on health and safety performance.
- The final draft of the Chairman's Objectives and Values contained no reference to health and safety until the omission was pointed out by the Group Health and Safety Adviser.
- The rules of the prestigious Hinton Trophy competition, in which safety had played an important part in the criteria for success, were redrafted in 1994. Hence forward, the competition was focused much less on safety to the extent that the report of the competition result, in the December 1994 edition of, the Grid magazine, contained no reference to safety.

7.4 Policy

7.4.1 Policy Structure

Most of the safety-related policy in place in PSB is derived from the various sources of policy issued to the NGC Businesses by Group Headquarters. This policy embraces that which is *mandatory* on the businesses through to *policy advice*, which allows some managerial discretion. As part of the arrangements for Corporate Governance, the NGC Board established in 1993, (Drew, 1990), a three-tier suite of policy documents comprising: (See Section 6.3.2)

- Group Policy Statements
- Business Procedures

- Local Instructions.

This structure was consistent with the aim of a Group operating as a decentralised organisation. Group Policy Statements were relatively few in number and established principles rather than detail. They were restricted to issues that met a limited number of criteria:

A Group Policy was required if:

- It assisted the Group Directors in meeting their legal obligations
- It was required in order to promulgate NGC's Objectives and Values
- It would help to demonstrate openness, integrity and accountability to shareholders in order to demonstrate NGC's continuing commitment to the highest standards of corporate governance.
- Non-compliance with the Group Policy Statement would prejudice NGC's best interests if not operated consistently throughout the Group.

In accordance with these criteria a Group Policy Statement on Health and Safety was issued in July 1993 (NGC, 1993a).

When the Group Policy Statement on Health and Safety was issued, the existing NGC Health and Safety Policy Statement (which was issued in compliance with Section 2 (3) of the Health and Safety at Work etc. Act 1974), was designated a Business Procedure and was re-titled the General Policy Statement on Health and Safety. It was still issued under the signature of the Chairman and was mandatory in respect of all operations and activities of the NGC Group in the UK. Similarly, the existing Policy Statement on the Safety of the Public (not a document required by statute), was designated a Business Procedure and re-titled a General Policy Statement (NGC, 1993b). It remained mandatory and was issued under the signature of the Chairman.

The simplicity of the NGC policy structure taken literally, was incapable of meeting the Company's statutory requirements. Rather than modify the policy structure, the policy documents were adjusted to achieve the same effect whilst giving the appearance that the policy structure was intact.

Many of the supporting safety policy documents issued by Group Headquarters, such as the Safety Rules and various Codes of Practice, were themselves based on statutory

requirements and were, necessarily, quite detailed. They were therefore designated as "model" Business Procedures and were effectively understood to be mandatory. Certain documents which were issued as guidance, such as the Management Guidance on the Management of Safety (NGC, 1990a), were endorsed by the Chief Executive and whilst they were not mandatory, they remained "compelling advice". Other documents issued from Group Headquarters, such as Safety Notes, were advisory although, in many cases, the advice given, would be difficult for managers to ignore.

There was therefore a range of safety policy documentation emanating from Group Headquarters, which was unarguably mandatory at one extreme and advisory at the other, with the items in between being compelling to some degree i.e.:



Another Group Policy that impacted on the management of safety, was the Company's Agreement on terms and conditions. This included the arrangements for establishing Local Councils and Local Health and Safety Advisory Committees.

7.4.2 Application of Policy within PSB

Certain of the policy documents identified above applied directly within PSB without alteration. Other policy documents were not applicable and unless converted into local policy documents. (This distinction is identified in Figure 8) The diagram also indicates that NGC Group was not the only source of policy advice bearing on health and safety. The Electricity Association is an additional source of specialist advice in the area of occupational hygiene. The audit link between Group and PSB served a dual purpose. The Group safety staff fulfilled a dual role when conducting audits in PSB. They were acting as true external auditors on behalf of the NGC Directors and also were acting as advisors to local management. PSB internal audit activity is also identified on the diagram.

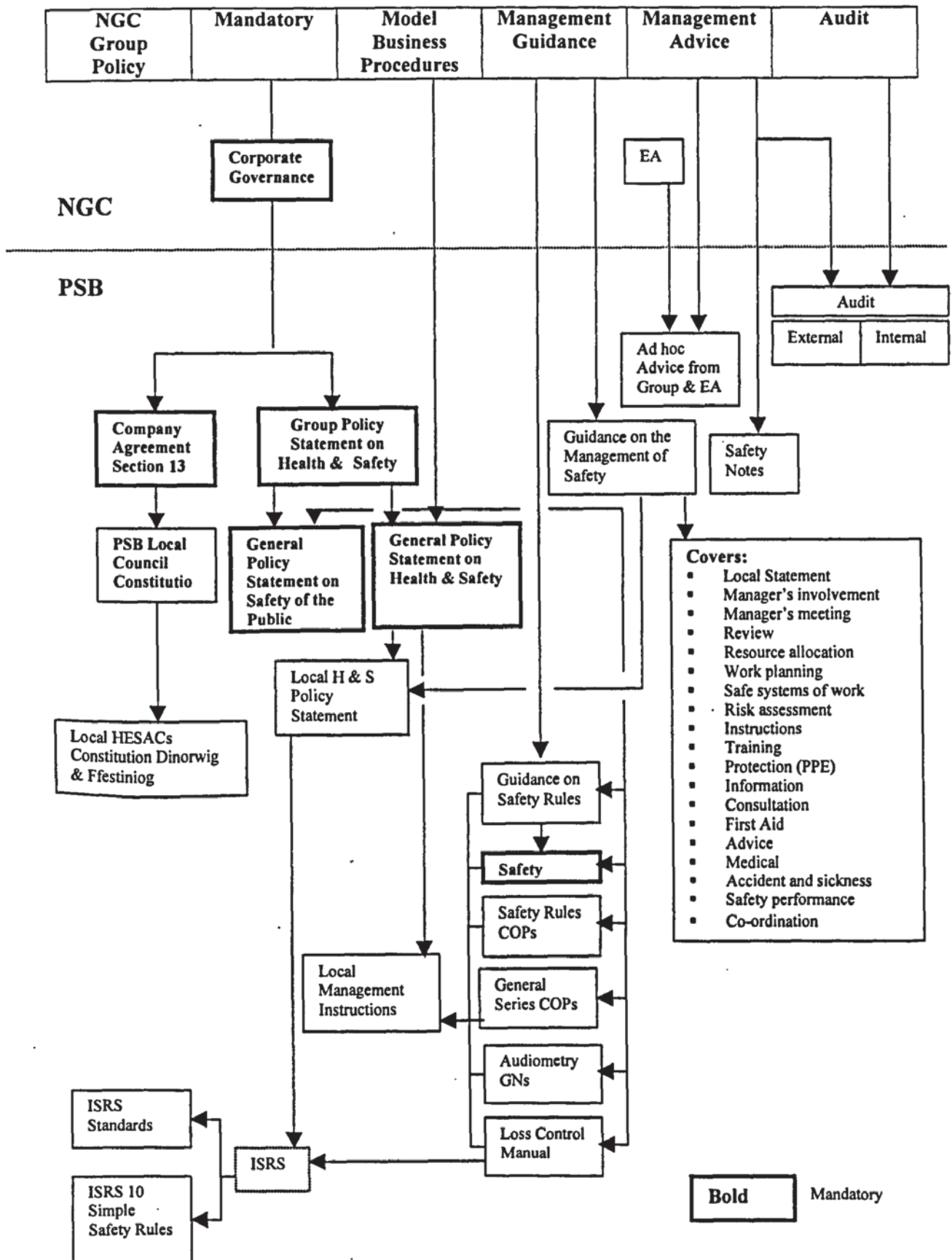


Figure 8: The Structure of Safety Policy in PSB

The Group Statement sets out NGC policy objectives and commitment in very broad terms. It suggests that loss control technique should be considered whenever appropriate. The General Statement on the Safety of the Public sets out the Company commitment in more detail by identifying the areas to which effort must be expended to avoid danger to the public (e.g. emissions, research, fences, overhead lines, signs, water intakes, excavations, premises with public access etc.) It identifies management responsibility, as well as the guidance and advice offered to the public. It states that the effectiveness of the policy will be monitored by independent audit.

The General Policy Statement on Health and Safety specifies the organisation and arrangements for implementing the Company Policy, the role of Safety Rules, the role of Consultative Bodies and Safety Representatives and it specifies in detail, the requirements imposed on the location manager i.e.

- “To implement the National Grid Company Health and Safety Policy at the location and, in particular, to issue a Local Safety Statement setting out how the Policy is to be applied locally, taking into account any special requirements of the location.
- To ensure that proper use is made of risk assessments which identify significant risks and to ensure that such risks are eliminated, avoided, or controlled.
- To allocate sufficient resources to provide and maintain conditions and places of work that are, so far as is reasonably practicable, safe and healthy.
- To take all reasonably practicable steps to ensure that premises in which work is carried out are operated and maintained so as to ensure so far as is reasonably practicable, a safe and healthy system of working.
- To ensure that adequate instruction is given to all supervisors and employees on all aspects of their work.
- To ensure that all staff are adequately trained for the work they have to do.
- To provide, where necessary, approved protective clothing and safety equipment and ensure that its proper use is understood.
- To take all reasonable steps to inform employees about materials, substances, equipment or processes used in their work which are known to be potentially hazardous to health and safety.
- To keep all operations and methods of work under review so they can, if necessary, be revised in the light of experience and up-to-date knowledge.
- To promote, through the established machinery, joint consultation in health and safety matters to ensure effective participation by all employees.

- To promote appropriate facilities for first aid.
- To seek advice, where appropriate, when potentially hazardous situations exist or might arise.
- To seek advice, where appropriate, professional medical advice on job suitability both before appointment and on return to work after serious illness; this advice is also to be obtained to assist in the placement of disabled persons.
- To collect, analyse and promulgate data on accident, sickness and incidents involving personal injury or injury to health and to investigate all such occurrences, and ensure that recommendations are made to prevent a reoccurrence.
- To consult with the Safety Advisor on the safety performance target for his location and to agree a suitable target with his manager.
- To identify and set safety performance targets within the location.
- To co-ordinate effectively National Grid Company activities and those of contractors working on Company property, with particular reference to the implementation and maintenance of safe systems of work, so that the Company and each contractor are able fully to comply with their legal obligations with regard to health, safety and welfare of their own employees and others.”

The Management Guidance on the Management of Safety was structured to provide amplification and advice on discharging each of the requirements placed on the Location Manager.

This was the broad policy framework in which the Business and location managers were expected to manage safety. More specific technical policy detail was contained in a further range of documents including the NGC Safety Rules. The Safety Rules apply to all work or testing on the electro-mechanical System and specify the requirements for ensuring safety from the system (such as isolation, earthing, draining, venting, purging etc.) as well as for ensuring general safety. The Rules identify responsibilities of persons authorised to work on the system and the safety document procedures which must be observed and also identify responsibilities for releasing equipment for work to be done and for controlling and maintaining the necessary safety precautions during the work. A suite of Safety Rule Codes of Practice set out in detail, the safety precautions to be observed in relation to specific types of equipment and a Management Guidance Document on the Safety Rules gives detailed advice in relation to individual Rules. A

General Series of Codes of Practice provides detailed safety policy guidance in relation to:

- Administration Procedure
- Chemical Hazards
- Electrical Hazards
- Environmental Hygiene
- Fire
- Mechanical Hazards
- Management Procedures
- Occupational Health
- Operational procedures

Safety Notes are issued by the Group Safety function to promulgate information and advice. The Safety Notes are structured in a series which mirrors the various series of Codes of Practice. A further source of policy advice is the Loss Control Manual. This was prepared as guidance to managers in support of their adoption of the International Safety Rating System, ISRS. The Manual also contains Model Standards in accordance with the ISRS audit programme.

7.4.3 Business Involvement in Policy Development

It should be noted that the Safety Adviser obtained the agreement of the Directors and General Managers in 1989, to the establishment of a Safety Advisory Panel, which was chaired by the Safety Adviser and upon which the main NGC Businesses were each represented by a senior manager. The Panel existed to advise the Safety Adviser in the formulation of Safety policy and all significant policy developments including Codes of Practice and Safety Rule issues were debated in that forum. This served as a powerful consultative link with the Businesses, including PSB, to ensure that their needs were properly considered. Detailed work on the preparation of Codes of Practice or other significant issues would frequently be delegated by the Panel to a Working Group representing the Group Safety function and the appropriate Business representatives. The Panel was re-titled and reconstituted as the Health and Safety Advisory Group in 1992 to reflect organisational changes in the Group Health and Safety function and in

the Business groupings within NGC but its functions remained the same. The Pumped Storage Business was represented on the Safety Advisory Panel and later on the Health and Safety Advisory Group, by the Production Manager from Dinorwig.

7.4.4 Comment on the Evolution of Policy

The policy structure represents a continuing evolution in response to the formation and development of NGC as an organisation with much authority devolved to its various Businesses and to location managers. The initial statutory Health and Safety Policy Statement, issued when NGC was formed, was a modified version of the previous CEGB Statement. There were two main reasons for this:

- The CEGB Statement was believed to be good in content and coverage in relation to official HSE Guidance.
- It was believed to be essential to avoid any suggestion that standards of safety would be in any way diminished by privatisation.

Both reasons argued strongly for maintaining continuity by minimising change.

For similar reasons, the NGC Safety Rules represented minimal change from the CEGB 4th Edition Safety Rules. In this case, it was recognised that a number of simplifications to the Rules could be made but it was agreed by the NGC Executive that it was particularly important to keep the Rules unchanged for some time after privatisation, to emphasise the intention that standards were to be maintained.

The Statutory Health and Safety Policy Statement issued in 1989 was changed in 1993 to accommodate the new NGC policy structure. This Statement became the basis of the General Policy Statement on Health and Safety and the new version reflected changes, to the organisation of the NGC health and safety function, the requirements of the Management of Health and Safety at Work Regulations 1992, (specifically risk assessment) and also Quality Assurance (QA) procedures. The General Policy Statement was further amended in 1994 to take account of the management responsibilities in locations which accommodate several business streams. The document was also now issued under the signature of the Chief Executive rather than the Chairman, to reflect the fact that the Chief Executive was in charge of the day to day management of the Company.

The Safety Rules were also revised during 1994 following acceptance by the NGC Executive in 1993 of a paper from the Safety Adviser suggesting a review of the Rules.

The revised Safety Rules were introduced on 5th February 1995. The changes mainly involved simplification and reduction in the number of types of Safety Document as well as deletion of procedures not used. Changes were also made to the structure of some of the supporting documentation as well as textual changes to align with the revised Rules. The Safety Rules Guidance Document was similarly revised.

The edifice of mandatory policy and policy guidance and advice, reflects the CEGB cultural inheritance. It is formally and logically structured and is comprehensive in coverage. It also reflects the high level of competence of the in-house professional advice within the safety function. This in turn, may reflect the intrinsic importance placed upon safety and certainly the importance of a strong safety image, by those initially responsible for setting up the National Grid Company. Whether emphasis is placed on the image or the substance is perhaps more likely to be revealed with the passage of time as the NGC evolves.

The policy evolution described, indicates a conservative and cautious approach which seeks to maintain the best of the past whilst moving forward with the development of NGC's organisational structure. It is also evident the Safety policy is formulated in consultation with the Business interests and is not simply imposed from the centre.

The document Management Guidance on the Management of Safety emphasises the importance of:

- Management leadership, supervision and control
- A systematic approach
- Planning
- Agreed performance targets
- Inspection Monitoring and Review
- Training and instruction
- Communication
- Consultation and co-ordination
- Thorough investigation

In association with the encouragement from Group to adopt a Loss Control approach and the ISRS system, it is clear that the NGC policy structure as it touched PSB, was

consistent with and anticipated the HSE 1991 publications, Successful Health and Safety Management and The Costs of Accidents at Work, HS(G)65, 1991 and HS(G) 96, 1993.

From the above it is reasonable to conclude that the NGC policy structure content and coverage, impacting on the management of safety in PSB, was of high quality and consistent with current thinking and authoritative external advice, including that of the enforcing authorities.

7.5 Principal Hazards and Relevant Legislation

7.5.1 Principal Hazards

Of the three premises within PSB, Bala House, being a modern office building, represents the least hazardous environment with regard to managing safety.

At Ffestiniog the greatest hazards are mechanical and electrical associated with the generation of electricity and the risk of flooding or fire within the power station. The remaining hazards are similar to those found in most industrial environments.

At Dinorwig the hazards are similar to Ffestiniog but the fact that the power station is situated entirely underground and below the level of the lower lake, makes the flooding hazard more acute, whilst the fire and smoke hazard is also exacerbated by the underground tunnel complex.

The condition of the dams at both power stations must be continually monitored.

A further hazard specific to PSB arises from the fact that much of the land surrounding the power stations and owned by PSB, contains numerous old quarry and mine workings which can represent a danger to members of the public walking in the area.

7.5.2 Relevant Legislation

Safety-related legislation applying to PSB principally comprises:

- The Health and Safety at Work etc. Act 1974
- The Factories Act 1961
- The Offices Shops and Railway Premises Act 1963
- The Fire Precautions Act 1971
- The Reservoirs Act
- The Occupiers Liability Act 1957, 1984

.... together with the Regulations made under those Acts appropriate to activities and

plant relevant to the Business.

Although many Regulations are applicable within PSB, perhaps the three most significant are:

- The Electricity at Work Regulations 1989
- The Management of Health and Safety at Work Regulations 1992
- The Safety Representatives and Safety Committees Regulations 1977

The enforcement agencies impacting on the management of safety in PSB are the Health and Safety Executive at Dinorwig and Ffestiniog, Fire Authorities at all three sites and the Local Authority Inspectorate at all three sites.

7.6 Management Structure, Responsibilities and Relationships

7.6.1 Overall Management Structure

The 1994 management structure of PSB and associated reporting relationships is outlined in Section 4.7.2 and Fig.6. The following account is a description of the situation in 1994/95.

The majority of PSB staff (139 out of 192 full-time staff), report directly or indirectly to the Plant Manager (98 at Dinorwig and 41 at Ffestiniog). The Engineering Development Manager controls a further 28 staff. The Business Strategy Manager and Commercial Manager, both located at Bala House, control a further 13 and 6 staff respectively. In addition to the 192 full time staff, the total staff in post, as at 30th September 1994, included 26 part time and agency staff.

An important factor in the working of the management relationships is that staff within the organisational structure are located in three different sites, which are each separated in travelling time by approximately 1 to 1½ hours. This limits face to face interaction between some direct reports and between other staff who are located at different sites.

The Business Strategy Manager and his staff are located at Bala House with the exception of the Business Accountant, who is located at Dinorwig, the site which accounts for the major spend. The Business Strategy team in its concentration on business development and investment opportunities, tends to have many interfaces

external to PSB although the external development arm of PSB Business Strategy, International Hydro, draws heavily upon the technical expertise within the PSB power stations to resource its overseas work. The Commercial Manager and his staff, also located at Bala House, has interfaces mainly external to PSB. The Commercial team traders provide the strategies against which the shift engineers at both power stations submit bids to Grid Control every evening.

The Plant Manager, located at Dinorwig, is responsible for operations and maintenance at both power stations with one of his direct reports being the Production Manager at Ffestiniog. The Engineering Development Manager, also located at Dinorwig, is similarly responsible for engineering development at both power stations. Two engineers at Ffestiniog are responsible to his staff for mechanical engineering and electrical engineering, control and information respectively. Functional control in these areas at Ffestiniog is therefore direct to Dinorwig rather than through the Ffestiniog Production Manager. Similarly the public guides at Ffestiniog are responsible direct to the Environmental and Amenities Manager at Dinorwig rather than to the Ffestiniog Production Manager. The security staff and the storekeepers at Ffestiniog are responsible to the Warden at Dinorwig to the Procurement and Contracts Officer at Dinorwig respectively. Apart from the reporting relationships noted above, the Production Manager at Ffestiniog is de facto site manager. The IT Sections at Dinorwig interface with all of PSB.

Individual job descriptions have been avoided in PSB as a matter of policy. They are regarded as potentially leading to restrictive attitudes and unhelpful to a management seeking to promote flexible working practices.

7.6.2 Formal Responsibilities for General Safety

The responsibilities of all staff in relation to safety are set out in the PSB Local Health and Safety Statement (PSB, 1994), issued in January 1994 in accordance with the NGC General Policy Statement on Health and Safety and the Guidance to Managers on the Management of Safety. The personal responsibilities of the General Manager (GM), are listed in detail in the Local Statement and mirror the Group Policy and Guidance except in the following respects:

- The Local policy additionally includes a reference to the formation of fire-fighting teams which is not included in Group documents because Dinorwig is the only location in NGC with a fire-fighting team.
- The Local policy omits reference to safety training under the personal responsibilities of the GM, although it does contain a separate section on safety training.

The Plant Manager is identified as being responsible for discharging the policy requirements of the General Manager during his absence. All Departmental Heads are specifically responsible for assessing all risks to health and safety within their sphere of responsibility and for providing safe systems of work. The responsibilities of all supervisors are identified, although in an entirely reactive manner. There is no specific requirement placed on the supervisors to inspect, audit or monitor activities in their own or other spheres.

The Safety Representatives and Safety Committees Regulations 1977, specify that Safety Representatives have *functions* not *responsibilities* but the Local Policy Statement implies that they have responsibilities as though they were performing a management function. Responsibilities are placed on all employees which include a responsibility to:

“raise with their Safety Representatives any actions taken by supervisors relating to hazards or concerns they have reported, where they are dissatisfied with the action taken.”

Other matters covered by the Local Statement, include Good Housekeeping, Emergency Control (Dinorwig) Plan, Emergency Control and Evacuation Plan, Accident Reporting, Safety Rules, Local Health and Safety Committees, Safety Representatives, Protective Clothing and Equipment, Training, Safety of Contractors, Safety of Visitors, a Schedule of Hazards and a schedule of sources of Advice as well as a list of employees with specific responsibilities (e.g. COSHH Officer, Fire Prevention Officer), Health and Safety Committee Members and reporting relationships.

The reference to Safety Representatives incorrectly states that the HASAWA 1974 *requires* each location to appoint Safety Representatives. There is no such legal requirement. Responsibility for observance of the Local Policy Statement out of office hours, at the power stations, is vested in the shift engineers.

In total, the Local Health and Safety Policy Statement is a generally good and comprehensive policy document but is inaccurate in some of its detailed references to Safety Representatives and there is scope for strengthening its references to the responsibilities of supervisors to require them to be more proactive in respect of safety.

7.6.3 Formal Responsibilities for the Safety Rules

Responsibilities for safety during work on the electromechanical system are independent of the line management structure and are set down in the NGC Safety Rules. Those who are allowed to work on the system must be *Competent Persons* as defined in the Rules i.e. *with sufficient technical knowledge and/or experience to avoid danger*. When specifically nominated to do so, a Competent Person may receive Safety Documents for work on the system. An individual may be *Authorised* to undertake specific activities such as isolation and earthing and if *Senior Authorised*, can issue Safety Documents. The actions of controlling and co-ordinating safety activities on the system are carried out by *Control Persons*.

The Rules and supporting documentation set down the requirements to achieve *Safety from the System*, as well as the responsibilities of the Authorised Persons and Control Persons involved in the application, co-ordination and control of the precautions. The Rules specify in detail, the particular responsibilities of the Senior Authorised Persons issuing Safety Documents as well as the responsibilities of nominated Competent Persons receiving the Documents, including their responsibility to the working party they may be leading.

Before being appointed as an Authorised, Senior Authorised or Control Person, the individual would attend a course at the NGC Training Centre at Eakring, Nottinghamshire. Before any individual is Senior Authorised he must attend an Authorisation panel, comprising the Plant Manager as chairman and other senior PSB engineering staff as well as a member of the NGC Group safety function. At the time of the research, no individual in PSB was Authorised without also being Senior Authorised. Very low staff turnover means that Authorisation Panels are rare events, although refresher training courses are held occasionally by one of the instructors from Eakring visiting the site. The Rules also apply to contractors working on the system.

Contractor employees are interviewed by a Senior Authorised Person before being nominated as Competent Persons who can receive Safety Documents.

New NGC Safety Rules were introduced during the period of research (on 5th February 1995). In preparation for the introduction of the new Rules, a Senior Authorised Person from Ffestiniog attended a course on the Rules at Eakring and he then held seminars for the staff at Dinorwig and Ffestiniog, to familiarise them with the requirements of the new Rules. He used training materials and handouts provided by Eakring. Each person with responsibilities for applying safety precautions and for issuing or receiving Safety Documents was then expected to use an interactive computer training programme which was in three parts covering respectively, training, refreshing and assessment. Each candidate subsequently attended a panel chaired by the Plant Manager at Dinorwig, or the Production Manager at Ffestiniog, before his authorisation under the new Rules was confirmed.

The impression created by the above is of a highly disciplined approach to the management of safety, based upon a well developed comprehensive Safety Rule system, backed up by training and a rigorous approach to the appointment of staff with duties under the Rules. Whilst this is largely true, a number of observations made on site and information gleaned from interviews tends to undermine this image. *(It must be stressed that no work on the system which was unsafe, was observed during the research.)* Site observations relating to the application of the Safety Rules are noted in Chapter 8.

7.7 The Design Safety Approach

7.7.1 General (Technical details in 7.7 derived from GD CD, (1983), see 7.7.1)

The safety management systems required in any facility will be dictated to some extent by the nature of the design of the installation and plant. It is probable that the safety management systems and the approach to the management of safety, will be a function of the complexity of the design and the nature of the hazards. Of the three PSB sites, Dinorwig presents the greatest challenge by virtue of the size of the underground complex, scale of the plant and the potential for catastrophic consequences in the event of flood or fire. It is therefore useful to consider the approach taken to safety issues in the design and building of the installation. This is an important aspect of the cultural inheritance of PSB.

The CEGB Generation Development and Construction Division, which was responsible for the design of Dinorwig, produced in March 1983, a Station Safety Report (GDCCD, 1983), which details the design approach to the specific hazards of the installation. The Report was intended to demonstrate that the special risks associated with the underground location had been properly considered and that suitable measures had been taken in the design, manufacture, testing and commissioning of the plant to ensure acceptable standards of safety. The special risks considered were:

- Flooding
- Fire and Smoke
- Toxic Fumes

Also included in the Report were statements relating to:

- Means of Escape
- Operating and Maintenance Instruction
- Loss of Grid Supplies

7.7.2 Operating Regime

The anticipated operating regime described in the Report, is based on Dinorwig being required to pump mainly at night and generate during the day and to provide dynamic response in the event of sudden loss of generation in-feed and automatic removal of pumping load in the event of low system frequency. The installation was thus seen as part of an integrated generation portfolio under common ownership. The operating regime in 1994/95 has therefore been modified from that originally envisaged to accommodate the commercial disciplines of the Pool arrangements.

7.7.3 Design Life

The design life of the civil works is stated as 80 years and the design life for the remainder of the plant is 40 years with the exception of the main inlet valve and upper penstock, which have a design life of 55 years.

7.7.4 Flooding

The whole of the main underground works is below the level of the lower reservoir thus providing the potential for complete flooding of the station. A comprehensive flood detection system is provided but the primary design consideration is prevention of

flooding, by high integrity design. The top reservoir can be isolated for maintenance purposes by the head-gates but even if these could be closed quickly, the volume of water in the high pressure (HP) system could flood the station. The essential design criterion is to prevent a leak in the high pressure system and the integrity of the system, the quality of the materials used and the QA techniques employed during manufacture and installation, are described in the Report. The maximum static head of water is 634 metres which is limited by the top dam. In addition, allowance must be made for frictional components and transient fluctuations caused by water-hammer and penstock resonance. The HP envelope was designed to Nuclear Class 1 pressure vessel standards and detailed stress analysis, photo-elastic modelling and strain gauge readings during proof loading were all employed to assess the design based on 15,000 mode changes/unit/year.

The Safety Report also specifies a regime of in-service inspections. Fingerprint data was gathered during testing and commissioning to provide reference data for later in-service tests. The Report considers other possible sources of water:

Auxiliary Connection to Main Hydraulic System

The worst leakage which could occur from the auxiliary connections is within the capacity of the emergency drain pumps.

Cooling Water System

The maximum possible leakage from the CW system exceeds the capacity of the drain pumps. Protection from the consequences of such a leak would be dependent on isolating valves. Adequate redundancy and diversity of valves is built into the design.

Fire Protection System

A failure of the fire protection main could result in leakage of the same order of magnitude as the total drain pump capacity and reliance is placed on isolating valves which have adequate redundancy and diversity. Two of the four emergency pumps could remove the water from the worst case scenario of an operation of the fire protection system.

Domestic Water Supply

This does not constitute a significant risk and can be readily isolated from outside the underground complex if necessary.

Seepage From Rock Surfaces

The design estimates were that this would be insignificant. It should be noted that a leak is currently occurring (February 1995), from a pipe used for draining excess water during the construction of the penstock. The pipe was subsequently concreted in situ. The leak was being monitored weekly and it was intended that the leak would be plugged by a high pressure grouting technique during 1995. (The leak was subsequently sealed successfully in 1996, see section 11.4.10 and Appendix B)

7.7.5 Hydraulic Isolation

The isolation of the top reservoir is by a main gate and a stop gate with emergency generation available at the head-works. The main gate takes 20-30 minutes to close and the stop gate three hours. Each pump turbine is isolated from the high pressure penstock by a single main inlet valve (MIV) which closes under gravity driven by counterweights and which can close against the maximum possible flow. The two sealing rings on the MIVs are driven by water pressure from the penstock. The design is intended to prevent common mode failures. Each pump turbine is isolated from the lower reservoir by a single draft tube valve DTV, closed by counterweights, which can close against maximum flow. The three tailraces can be isolated by main gates and stop gates and can be closed against a flow considerably in excess of the flow from a draft tube bypass line failure. Similar detailed consideration is given to the isolation of the cooling water (CW) and fire protection systems. The details of high integrity maintenance isolation, for work downstream of the MIV, are set out in the Report.

7.7.6 Flood Detection and Control

Drainage pumps are started automatically and indicated in the control room. Further rises in water level successively bring in a high level alarm, the first emergency drain pump and a second emergency drain pump followed by an extra high level alarm. Further alarms are activated if the water level continues to rise and are indicated in the control room. The emergency plan envisaged in the design report is that the Control Engineer will assess the rate of flooding and attempt to identify and isolate the source before ordering an evacuation. (The estimated time to flood the MIV gallery with a spiral casing manhole failure and no drain pumps, is thirteen minutes).

7.7.7 Fire and Smoke

The design minimised the use of flammable materials and the fire risk was considered low but smoke could present a significant hazard. The principal fire risks were considered to be transformer, lubricating and hydraulic oils and the electrical system insulating materials. Fixed fire protection is provided over main transformers and other vulnerable areas. Hydrants are provided throughout the complex and every alternate hydrant in the tunnels is provided with foam making equipment. The six generator motors are protected by BTM gas. All specific fire hazards are provided with two separate fire warning systems with smoke detectors in caverns and tunnels and with heat detectors in cable trays. All alarms and operations are annunciated in the control room.

The heating and ventilating system is controlled from the fire panel in the control room to deal with the extraction and the prevention of spread of smoke laden air. The Report specifies the action to be taken in the event of fire and also deals with the possibility of fumes from the use of BTM gas or a failure of containment of SF₆ gas.

The Report deals with means of emergency escape. A smoke door is provided which can segregate the two main tunnels to the surface. Emergency battery lighting is provided and the stations 2 x 1.7 MW diesel generators can also provide essential lighting throughout the complex. An emergency cable from the diesel sets is routed down each tunnel to segregate emergency supplies.

The design integrity of the civil works including the dams, tunnels and caverns, is covered in detail, as is the consideration given to quarry benches and lake margins. The comprehensive nature of the Station Safety Report is an indication of the thoroughness of the design approach and an impressive testament to the technical competence of the CEGB.

The present station staff includes many who were at Dinorwig at the time of commissioning, including the Plant Manager. The current operational and emergency procedures for are based on the design criteria in the Report. This legacy therefore sets a standard for the present procedures and is influential in forming the expectations and the attitudes of current staff. In effect it is a powerful cultural inheritance. The design criteria promotes the continuation of a technical and rule and procedure driven culture.

It may perhaps also be noted that the Safety Report is essentially technical and mechanistic in nature. It does not refer to human factors aspects of safety. It is interesting to note that when an electrical fault occurred in a switchroom in 1989, large quantities of smoke were generated which were not adequately extracted. This was because the appropriate fans were incorrectly selected to the section of switchboard that was affected by fault instead of to an independent supply. The most elaborate design features can thus be undermined by a latent failure in the form of a human error, which may lie undetected until a trigger event occurs.

Chapter 8

EVALUATION OF THE PSB SAFETY CULTURE

Part 2 – Site Observations

A stander-by may sometimes, perhaps, see more of the game than he that plays it.

Jonathan Swift 1667-1745

8.1 Introduction

This Chapter describes the data collected on site in 1994 and 1995, which was derived from discussions, interviews and direct observation of conditions and activities. The analysis under each heading includes factual data obtained as well as comment on the data. This section includes verbatim quotes which are identified within the text but which must remain unattributable in accordance with the agreement to respect the anonymity of staff. (See section 7.2.2).

8.2 Institutional Arrangements relevant to the Management of Safety

8.2.1 General

Section 8.2 examines the institutional arrangements within PSB, such as meetings (regular and ad hoc, executive and consultative) which have a bearing on the management of the business, site or department and directly or indirectly, on the management of safety. Also included is the contribution of the Safety Representative arrangements to this process.

8.2.2 Consultative Arrangements

The consultative arrangements are set out in Part 13 of the NGC Company Agreement. This specifies the terms of Reference and Constitution of the Local Council and of the Local Health and Safety Consultative Council (HESAC), which is to be established as a standing committee of the Local Council. The Local Council covers the Pumped Storage Business and is the forum for considering matters of common concern to the

Company and employees. There is also a Company Council and Company HESAC at NGC Group level. The functions of the Local Council include:

- “Discussion of the business plan, annual report, financial results, training and education and other issues.
- Receiving notification of decisions and communications from the Company Council.
- Considering differences relating to an employee or group of employees concerning the application of the Staff Agreement referred to the council either by the Company or staff representatives and to ensure that:
 - (a) all prior means for settling the difference have been explored
 - (b) wherever possible, to resolve the difficulty through joint agreement of the Council
 - (c) to communicate to the parties, the decision of the Local Council
 - (d) where any difference remains unresolved, to draw the attention of the Company Council to the matter
- To facilitate the consideration of health, safety and welfare at work of employees
- To inform staff locally of the Councils activities.”

The membership comprises representatives appointed by the Trade Unions such that all sectional interests are represented and representatives appointed by management. The Chair of the Local Council rotates annually between a staff representative and a management representative. The chairman during the period of research was the PSB General Manager. The Local Council is therefore both a negotiating and a consultative body dealing with differences concerning pay and conditions, as well as matters such as safety, health, welfare and training. There is no mechanism for referring unresolved issues upwards to the Company Council, although any such differences must be communicated to the Company Council. This is in accordance with the philosophy of devolved managerial authority and contrasts with previous CEGB arrangements where failure to agree was referred to a higher level. The present procedure is designed to force resolution at local level.

There are Local HESACs at Ffestiniog and at Dinorwig. The constitution and terms of reference of Local HESACs are set out in an agreement between NGC and the Trade Unions dated 19th April 1991. This agreement is a modification of a former national ESI agreement under which the Trade Unions and ESI Electricity Boards agreed on a common approach to the Safety Representatives and Safety Committees Regulations 1977. The constitution and terms of reference are consistent with those Regulations. The HESACs can consider all health and safety matters referred to them, either by the Local Council or by Safety Representatives. The membership of the Local HESACs comprises management and staff representatives, the latter being drawn from the staff

membership of the Local Council, together with the Safety Representatives from the respective sites. Bala House did not have a separate Local HESAC but a Safety Representative from Bala House attended the Ffestiniog HESAC and any issues related to Bala House were discussed there.

The Chair of the HESACs rotates annually between a staff representative and a management representative. During the period of the research, the chairman was the Plant Manager at Dinorwig and the Production Manager at Ffestiniog. The HESAC constitution states that the Committee can make recommendations to the General Manager for his consideration. The General Manager stated that it his policy to be proactive and “*to take the high ground.*”

8.2.3 Local Council Meetings

Two meetings of the Local Council were attended during the research. Each such meeting was preceded by side meetings of management and staff. The staff side meetings were observed to go on well beyond the agreed starting time of the full meetings to the extent that on one occasion, when the full meeting began, the staff suggested that in future they should have the side meetings on one day and the full meeting the next day! Subjects discussed were substantial issues covering, details of payments under the local agreement, business performance, International Hydro, New Safety Rules, safety performance, the use of contractors and consultants, the PSB Ideas Bank, good housekeeping, bonus payments to staff, updates on flotation, communications, severance and the prospect of remote control of Ffestiniog.

The Local Council meetings were a new forum, having been introduced as part of the NGC Company Agreement in March 1994. The Local Councils replaced the previously separate negotiating meetings of technical staff, clerical staff and industrial staff and the Local Joint Consultative Council meetings. Assimilation issues and payments arising out of the Company Agreement, were still being resolved and the Company Agreement had been particularly unpopular with shift staff in PSB. The prospect of flotation of NGC and the suggestion, (which became public knowledge in December 1994), that PSB would probably be de-merged from NGC and either owned by the RECs or sold separately, created uncertainty and suspicion amongst most PSB employees. This background probably explains the atmosphere of tension in which the meetings were conducted, the divisiveness of the meetings and overt hostility towards management

which sometimes characterised the discussions. (No similar hostility towards management was noted during interviews with staff.)

Staff complained of excessive use of contractors and consultants, of the lack of tangible results from the resources put into International Hydro and expressed their concerns about severance: *“Those who want to go, can't and those who have gone, come back as consultants”*

Management announced at the Local Council, an interim bonus payment to all staff in recognition of good business performance. The management were reporting particularly good business results and high levels of profitability because of high differentials between night and day pool prices. The financial and business data provided was very detailed, implying an openness and a willingness to share the maximum amount of information with staff. Management were also updating staff on the flotation issue which continued unresolved during the research period with staff being given the prospect of receiving more information every month from October 1994 to March 1995. However little further information was forthcoming because the Government (who hold the golden share in NGC), failed to come to a final decision. This delay increased frustration, anxiety and impatience amongst staff.

Staff complained that communication was poor, particularly in relation to the future of Ffestiniog, although this seemed to be a function more of the general atmosphere of uncertainty and suspicion, rather than being well-founded, as a very full presentation of the costs and issues concerning remote control at Ffestiniog had taken place on site and was repeated at the Local Council. Detailed discussion of trivial issues concerning Ffestiniog staff expenses, revealed the inappropriate use of the forum. The matters concerned had already been dealt with locally by management but the staff side were using the Local council as a "Court of Appeal" in relation to decisions they did not like. This subverted management authority and was resented by the Production Manager. (It was noted that certain staff representatives would appeal directly to the General Manager when he visited site. They believed that this resulted in action when direct appeal to line management had failed. This was resented by managers and supervisors alike).

PSB operate a suggestion scheme, "The Ideas Bank" but a considerable backlog had built up in dealing with submissions. This had resulted in disillusionment and a falling off in the rate of submissions. The issue was considered at the Local Council and more resources were devoted to the scheme, resulting in a significant reduction in the backlog during the research period. The person charged with administering the Ideas Bank had claimed that "safety ideas" were not part of the scheme although this was incorrect. He had been corrected but this had not encouraged safety suggestions.

Safety issues specifically discussed at the Local Council included the Safety Performance of PSB, measured in terms of accident frequency rate, the concerns of management at poor standards of housekeeping, concern by staff at the reasons for changing the Safety Rules and the concern of staff at oil mist in the machine hall at Dinorwig.

8.2.4 Local HESAC Meetings

Local HESACs were attended by the researcher at both Dinorwig and Ffestiniog. The issues discussed were substantial and included safety performance, good housekeeping, the use of BA equipment, emergency escape from cranes, fire training and the safety of contractors.

The tension which was present at the Local Council was absent in the deliberations of the HESACs, which were chaired by the Plant Manager at Dinorwig and the Production Manager at Ffestiniog. Detailed discussions took place in a participative manner and although both HESACs were consultative, they were run, by the managers chairing them, as executive bodies. The managers used the meeting to make management decisions following discussion and to place actions on staff. At Ffestiniog the Production Manager had some difficulty with staff representatives who were failing to meet deadlines for completion of actions or who were particularly inept. For example, a Safety Representative who was a shift engineer, had been organising a safety poster competition to which there had been a poor response. It emerged that he had not indicated where the entries should be returned nor had he set a closing date. In contrast, a Safety Representative at Dinorwig, a fitter, had shown considerable initiative in suggesting a trial of a back support for staff involved in lifting and moving. The same Safety Representative had organised displays of protective clothing and equipment for promoting the safety message to staff.

At Ffestiniog the HESAC expended much time discussing the need for improved lighting in an infrequently visited part of the station. In controlling the discussion and in arriving at a solution, the chairman was effectively carrying out a risk assessment. This was also true in relation to a discussion surrounding a "near miss," in which an oil drum had fallen from a sling. It was clear that it would be most useful if staff in general and safety representatives in particular, had an understanding of risk assessment thereby minimising unnecessary debate. A further matter discussed at the Ffestiniog HESAC was safety liaison with contractors. This discussion revealed an ignorance amongst shift engineers of the system which was supposed to be in place.

A near miss reporting scheme, the Confidential Hazard Incident Reporting Procedure (CHIRP), had been introduced into PSB by the Plant Manager, based on an RAF scheme. CHIRP reports were discussed at HESAC and management were generally pleased at the take-up of the CHIRP scheme.

8.2.5 Executive Meetings

The PSB Executive comprising the General Manager, Plant Manager, Commercial Manager and Business Strategy Manager meets every month. One such meeting was attended by the researcher. Items discussed included the PSB budget, business performance, International Hydro, safety performance and ISRS, the interim bonus payment to staff as well as flotation issues. The discussion of safety was quite detailed. It was acknowledged that accident frequency rate was a poor performance indicator and that this emphasised the greater usefulness of ISRS. Tensions with NGC Group were exposed during discussions of a number of subjects including the difficulty of the budget preparation timetable in relation to the demands of Group Finance, relationships with Group Business Development and International Hydro and difficulties with the Group Director concerning the payment of the interim bonus to staff. The overall impression created by the meeting was of a united management team working well together.

The PSB Board (the PSB Executive plus the Group Director and Group General Manager, Finance) meet quarterly immediately after a PSB Executive. The Engineering Manager holds an Engineering Meeting immediately after the PSB Executive but the Plant Manager has no formal regular meeting structure.

At both Dinorwig and Ffestiniog, a morning meeting is held every weekday involving the operations staff and certain day staff. At Dinorwig the Shift Production Engineer, the Planning Engineer and Maintenance Engineer discuss the rolling weekly programme of maintenance and operations. Safety requirements, such as the need for isolations and Safety Documents, are identified. The Planning Engineer updates his planned programme on computer during the meeting which lasts about one hour. At Ffestiniog, the morning meeting is chaired by the Production Manager and is attended by the Shift Charge Engineer, Maintenance Engineer and Planning Engineer. It lasts typically about half an hour. The Production Manager is updated by the shift Engineer and the current maintenance schedule is discussed along with current problems. The Ffestiniog meeting tends to range over site issues because of the presence of the Production Manager who is the senior person on the site. The meeting is particularly business-like and effective in effecting liaison between operations and maintenance. (e.g. a problem of excess pressure in a turbine casing was diagnosed as resulting from the guide vanes being too tight although at the beginning of the meeting the diagnosis was not apparent. Joint contributions assisted in identifying a solution.) The forum discussions also revealed weaknesses in communication between station staff and traders at Bala House, when it became clear that no one present knew why the bid price for the Ffestiniog machines was so high at a time when they were not being called upon to run.

The Head of Production at Dinorwig had introduced an Operations Plant meeting every six weeks to improve inter-départmental liaison and obtain better cohesion and to help meet individual performance targets. In addition, a major engineering project such as the installation of electronic governor gear on Unit 4 was preceded by a meeting between traders and station operations and engineering staff, again to improve effective liaison.

8.2.6 Engineering Meetings

The monthly Engineering Meeting at Ffestiniog was attended by the Engineering Section Heads from Dinorwig and went through the maintenance schedule systematically debating important issues. This meeting was businesslike but the sparring dialogue indicated an undercurrent of suspicion of Dinorwig, by the Ffestiniog staff. At Dinorwig it was reported that pre-outage meetings were normally held about one month prior to the outage and that Shift Production Engineers would sometimes attend. Strong

feeling was expressed that isolation difficulties were not resolved because: *“the Operations voice is not heard adequately and because Planning do not reveal their full hand.”*

8.3 General Issues Indirectly Bearing on the Management of Safety.

Various issues emerged from interviews and observations relating to management relationships within and between locations and between PSB and NGC. These did not necessarily bear directly on the management of safety but inevitably reflect, to various degrees, perception and reality and form part of the cultural background within PSB.

8.3.1 The View From Ffestiniog

Many interviewees from both Dinorwig and Ffestiniog referred to a historical conflict between the operations and maintenance departments at Ffestiniog. This was said to originate with a former CEGB station manager at Ffestiniog and the then maintenance and operations engineers. The station manager favoured the operations engineer and there was mutual animosity between the two engineers. Although they had adjoining offices, they would rarely speak to each other and gave minimal co-operation which was reflected down into their respective staffs. The operations staff were centred on the Control Room, which is on the opposite end of the power station to the workshops, where the maintenance staff were centred. The two Departments were said to have been: *“us and them.”* The CEGB station manager and the operations engineer retired many years ago. The maintenance engineer became station manager but the echoes of the past persisted.

The new station manager remained in post through privatisation and the during the formation of PSB. He had therefore been at Ffestiniog when it was the senior station in the CEGB North Wales Hydro Group and saw the other stations in the Group allocated to Nuclear Electric and National Power, while Ffestiniog itself became a station managed from Dinorwig. It was reported that he never came fully to terms with this relationship. This attitude of resentment towards Dinorwig was referred to by staff at both sites. At Ffestiniog feelings were expressed in statements such as, *“we get hand me downs from Dinorwig” ... “Dinorwig got a new covered stores but Ffestiniog got an outdoor compound.”* A relatively trivial administrative mix-up relating to a dinner given for Ffestiniog staff, *“would not have happened at Dinorwig” ... “things at Dinorwig are*

done straight away, Ffestiniog waits” ... “Ffestiniog was once the king-pin and the general attitude of staff now is, what do Dinorwig know?”

The change in operating regime since privatisation has resulted in a difference in work patterns and demands. Fitters, supervisors, engineers and management all acknowledged the importance of availability: *“availability is everything” ... “much sharper deadlines” ... “overhauls done at breakneck speed” ... “quicker turnaround on outages.”*

The Production Manager pointed out that if a problem arose, when Grid Control asked them to bring on a set, it was important for engineers to identify problems that they could not solve quickly so that they could declare the set unavailable. The cost penalty of trying and failing to fix the problem in time was at least £5000 at Ffestiniog and much more at Dinorwig. Engineers therefore had to resist the normal impulse to effect a repair. The change in emphasis was identified particularly by the shift engineers who themselves submit the commercial bids each day: *“we are here to generate profits, not electricity.”*

In spite of this change of emphasis, links with Bala House amongst the shift engineers and the senior engineering staff were weak: *“traders don’t appreciate what you are doing which is frustrating and irritating” ... “we never see the people from Bala House.”* Senior engineering staff stated that they had never visited Bala House and even the Production Manager had never been to a business meeting there.

In spite of the increased urgency of operational deadlines, fitters and engineers stressed that the management of PSB were not prepared to see safety standards fall and that, if anything, there was greater emphasis on safety: *“Safety still has a high profile” ... “There has been no change in safety standards” ... “Management have been more concerned about safety since PSB started, they don’t like the Accident rate being high” ... “management won’t compromise on safety but staff may compromise” ... “There is fatigue at the end of an overhaul.”* No one interviewed could quote an instance of safety being compromised by pressure of work.

The impression obtained was that there was no evidence of over-demanding work schedules. Generally, staffing levels appeared generous and individual fitters, supervisors and engineers variously acknowledged that the pace of work was reasonably

relaxed and that the location was over-staffed, a view shared by the Production Manager.

A particular focus of resentment by fitters and supervisors was what they regarded as excessive use of contractors. Supervisors cited instances in which they said contractors had damaged plant. Fitters claimed that the work that contractors did could be done in-house and that it would be preferable to develop their own skills. These arguments were repeated in the forum of the Local Council Meeting. It was said by a senior manager at Dinorwig, that the hostility towards contractors at Ffestiniog extended towards Dinorwig staff when they were sent to assist on major outages. Engineers also claimed that excessive use was made of consultants, particularly by the Engineering Department. Another focus of concern was International Hydro. Individuals expressed concern that International Hydro was *“soaking up manpower and money with nothing to show.”* These concerns were also repeated in the Local Council.

Interviewees readily acknowledged that more money had been spent on the plant at Ffestiniog since privatisation (40% of total engineering spend) and that PSB provided *“good conditions and equipment and had invested in tools, machinery and plant.”* Staff volunteered that PSB was a good employer and the Production Manager pointed out that pay rates were at least 25% higher than those of any other local employer. The perception of Ffestiniog by three senior Dinorwig engineering staff was of a *“slower pace, cautious and apprehensive about Big Brother Dinorwig.”* Another referred to a fax from Ffestiniog *“contractors will be mending the security cameras in about two weeks” - that sums up Ffestiniog, manyana.”* whilst another regarded Ffestiniog staff *“as particularly good in productivity and engineering, producing very high quality work and willing to learn.”* (the latter individual would deal mainly with non-operational staff.)

Staff at Ffestiniog acknowledged that problems could arise from close relationships amongst a small workforce with low turnover: *“supervisors familiarity with staff leads to poor supervision”... “everyone knows everyone else and it’s difficult to challenge things, you can’t point a finger if something goes wrong.”*

Ffestiniog was in many respects a conservative working unit in relation to working practices. As one shift engineer said, *“the way of working here has not changed since commissioning.”*

The Production Manager at Ffestiniog was appointed from Dinorwig in mid 1994 and was therefore familiar with the history of Ffestiniog. He had instituted a number of changes to overcome some of the difficulties of the past. The Operation and Maintenance Departments were now combined into one Production Department and the Production Manager was therefore directly in charge of both groups of staff. He had identified the relative strengths and weaknesses of his staff and had taken action to promote better co-ordination and liaison. He held a morning meeting every day attended by the Shift Engineer, the Planning Engineer and the Maintenance Engineer which reviewed current operational issues. He had instituted a Production Meeting at monthly intervals to ensure that operations and maintenance were better co-ordinated on a longer planning time-scale. He had held a pre-commissioning meeting between his own staff and had deliberately involved a Trader from Bala House to promote better understanding prior to major work on the Governor system of one of the sets. Spare shift operations staff were now helping out with maintenance activity. All of these changes, together with personnel changes, seemed to be having considerable effect. The Production Manager himself spoke Welsh as his first language, he had started work as a fitter and obtained a First Class Honours Degree in Electrical Engineering. Many staff spoke of their respect for him. It was evident to him and to the staff at Ffestiniog, that in order to remain competitive, costs must continue to be cut and that technology had clearly made it inevitable that the long term future of Ffestiniog was as a de-manned station, operated remotely from Dinorwig. The Production Manager was confident that with the age profile at Ffestiniog and with careful planning, this could be achieved by a controlled run-down in staff numbers, using early retirement, retraining and re-deployment to Dinorwig. He had clear ideas of how to achieve this objective but was frustrated by his limited authority in this area.

There was no significant evidence of the tensions which were said formerly to have existed between Operations and Maintenance. As one fitter put it: *“It is now much less vindictive and amounts to good hearted rivalry usually about the available overtime.”*

The former conflict between Operations and Maintenance were fading into insignificance and whilst tensions with Dinorwig were evident, the justification for them appeared increasingly thin. The impression gained of Ffestiniog, was that the staff seemed largely content and readily acknowledged that PSB was a good employer offering good conditions and high standards of safety. Complaints were minor. Individual perceptions of Ffestiniog were lagging behind the reality. Things were changing at Ffestiniog but against the background of the inertia of a very stable community, in which the majority of staff have spent many years, it is not surprising that time seems to move more slowly.

8.3.2 The View From Dinorwig

At Dinorwig a number of specific issues emerged from observation and interview which had a bearing on management structure as well as responsibilities and associated relationships and perceptions. It was evident that the Planning Department was held in low esteem by shift engineers and foremen. Examples were cited of waste of resources in de-isolating and de-earthing only to be met with a planning requirement that required re-isolation and re-earthing of the same plant: *“Planning release work in dribs and drabs”* ... *“Planning don’t understand the plant”* and similar comments, were heard from many engineers. Several fitters were very critical of the organisation of work which they said was wasteful because of a lack of pre-planning: *“They couldn’t organise more than two jobs at once”* ... *“we spend too much time getting materials”* ... *“the job isn’t ready to start.”* It was also suggested that there was some tension between Engineering and Plant Departments. Engineering staff complained that they produced systems which Plant did not implement. Operations staff maintained that Engineering altered the plant without a proper system of informing operational staff and that this could be potentially dangerous.

At Dinorwig emphasis on plant availability was similar to that revealed at Ffestiniog. It was also claimed that there was some opposition at Dinorwig to outside contractors. The change of priorities since privatisation was a matter which particularly concerned shift engineers and as at Ffestiniog, many had difficulty in coming to terms with the new imperatives: *“Values are different to the CEGB”* ... *“It is now about money and profit not public service”* ... *“You cannot identify easily with the new values, they are worse than the old values”* ... *“You cannot have the same pride.”*

Several shift engineers expressed suspicion about the New Safety Rules and those who had studied them believed that they were transmission oriented and PSB should have its own Rules which, incidentally, would legitimise some of the breaches regularly made in the existing Rules (e.g. it was suggested that mechanical isolation and work should not necessarily require a Safety Document but should, in some circumstances be undertaken under oral instructions).

The use of teams brought together for specific tasks was well illustrated by the MIV bearing change project described in detail in Appendix A. Here a multi-functional team was created for the duration of the project and combined all the expertise necessary for the successful completion of the task.

A widely held view amongst engineers was that *“PSB Head Office should be at Dinorwig, not at Bala House.”* A feeling of “them and us” was reported and one senior manager said that *“gradings at Bala House are more akin to CHQ. They are higher than they would be at the power stations although there is little appreciation at Dinorwig that the culture at Bala House is not to claim overtime which is claimed by power station staff.”* The “remoteness” of Bala House was felt particularly acutely by certain senior members of staff, who had insufficient contact with Bala House and particularly with the General Manager. The General Manager was considered by senior staff to have too low a profile at Dinorwig and was seen by supervisors and fitters to be remote and aloof. This was in contrast to his predecessor, who had identified himself very much with the site and the staff. The IT Section, which is located at Dinorwig, appeared to be very concerned about its service and customers but the IT manager felt strongly that their efforts were not appreciated. He said that relations with the Commercial Department were poor. He was also concerned that his resources were too limited and that demands to support overseas work were difficult to meet. From Bala House the Business Strategy Manager offered the view that, *“it is difficult to get I.T. to do what you want.”*

The relationship with NGC Group was generally regarded as limiting and adding little value. International Hydro development strategy was limited in certain countries by the considerations of the activities of other parts of NGC. PSB was not free to pursue its

own recruitment and severance policies because of NGC and the NGC procurement function had been seen as so limiting that PSB had organised independent arrangements for such major items as travel and purchase of cars.

It was acknowledged that the bulk of NGC's business was Transmission, which was low risk but PSB was now a high risk business and that therefore one advantage of the link with NGC was financial security. Considerable irritation was caused to senior PSB management by the budget and business plan agreement process with NGC and at demands by NGC for further headcount reductions, after a figure had already been agreed.

In a number of interviews a tendency towards a self-sufficient stance, bordering on isolationist was noted, particularly in relation to the procurement and personnel functions but also in relation to engineering. This is perhaps not surprising as the PSB activity is unique in NGC and the previous General Manager had actively promoted a self-sufficient attitude within PSB. Another powerful incentive reinforcing self-sufficiency was the probability, which increased during the data collection period, that PSB would be de-merged from NGC in the event of the flotation of NGC. Staff at Dinorwig were concerned about the uncertainties surrounding flotation as Ffestiniog staff but the additional preoccupation with the future of their site was absent at Dinorwig.

An important background feature at Dinorwig was the consciousness amongst the staff that the site was operating profitably and particularly so during the research period, because of the large discrepancy between day and night time Pool prices. During at least one month, PSB contributed more profit to NGC than did the Transmission Business.

8.3.3 The View From Bala House

Staff interviewed at Bala House included clerical and administrative workers, traders and senior managers. PSB was regarded as a good employer, offering good conditions and evidence was cited of the consideration shown in times of personal distress. It was also said that PSB was "*good at giving responsibility*." Those whose work involved interfaces with Dinorwig and Ffestiniog suggested a feeling of "them and us" and an impression of division but found difficulty in providing examples. Dinorwig and

Ffestiniog were “rumour factories” and were “always suspicious”... “They think we know more than they do”... “All three units tend to be insular which can cause friction”... “They think I am a management spy,” one trader reported, “many of them don’t appreciate what we do and they believe closing down Bala House would save a lot of money.” Efforts were being made to improve understanding of the Bala House activities by inviting staff from Dinorwig and Ffestiniog to presentations made by Business Strategy and Commercial Department staff but in spite of these efforts, much suspicion and misunderstanding persisted.

The senior managers reporting directly to the General Manager initially numbered six and was reduced first to five and at the time of data collection stood at four, reducing in late 1995 to three. One of those senior managers acknowledged that stress levels were high but also acknowledged that no specific action had been taken to identify stress or to help staff with coping strategies. A feature of the recent Company Agreement is that all business travel is normally expected to be economy class. A recent visit to India had been necessary as part of International Hydro activities. The economy class itinerary had involved a flight from Manchester leaving at about 5a.m. getting into Delhi about midnight which was to be followed by an early internal flight the following morning. The expectation was that the travellers would sleep at Delhi airport since there would be insufficient time to book into a hotel. These arrangements had been endorsed by the General Manager. This illustrates the demands made upon staff, sometimes thoughtlessly. It was reported by senior staff at Bala House that they found difficulty in obtaining time with the General Manager who tended to use his personal assistant as his communication medium.

8.3.4 Some Senior Management Views

The view of NGC from the perspective of the senior management of PSB, was that it had moved well away from the original Blueprint principles and was now much more centralist. The Chief Executive who took up office in April 1994 was seen as a centralist and most of the existing Executive Directors were believed to be centralist by nature. The PSB Business Report had previously been made to the NGC Management Executive quarterly but was now expected every month. PSB saw no benefit from this and did not believe the Group Directors benefited. The original Blueprint had envisaged Directors being focused on the Group rather than having Businesses reporting directly

to them but PSB reported directly to a Director, as did PNB. Although the Blueprint philosophy was one of devolving authority, the creation of PNB had meant that the greater part of NGC staff and resources (i.e. Transmission areas) were effectively contractors to PNB. The former centralist role of HQ had thus been replaced by PNB.

A system recently introduced by NGC Group for communicating to staff, was seen as a bureaucratic and formalised means of cascading information. The General Manager had refused to introduce the scheme in PSB. He believed that the existing PSB practice was preferable whereby, at every PSB Executive Meeting, the ten most important messages to be communicated to staff were identified and actions placed on his direct reports to ensure that those messages were conveyed within five days. He saw no purpose in replacing a simple and effective mechanism with a bureaucratic meeting structure. NGC was seen as providing financial strength and economies of scale in certain areas of activity but NGC Group Policies were not thought to be necessarily the best for PSB. The General Manager had tried to promote culture change in PSB by using his senior direct reports as Assistant General Managers and by encouraging team working, but believed the greatest present weakness was in the staff at the level reporting to his direct reports. He was anxious that they should identify with the senior management team.

One of the senior managers stated that he believed PSB's priority was to make profits but that he believed it essential that PSB must deliver value to shareholders, customers and staff and that he believed that *"the difference between a good and an excellent manager is in the emphasis placed on staff."*

8.4 Procedures for the Management of Safety

8.4.1 Introduction

The policy structure relating to the management of safety in PSB is described in section 7.3. This section contains discussion of the procedures, comment on the application of specific procedures and analysis of the scope, coverage and detail of the procedural approach to safety. It does not purport to be a comprehensive detailed analysis of each procedure.

Examination of the procedures reveals that they are technically sound and reflect the quality of the policy guidance issued from NGC Group. In many respects the procedures relating to the plant are developments of pre-existing procedures. Comments in relation to the adequacy or otherwise of the procedures, derived from interview and direct observation, are given below:

8.4.2 ISRS

PSB requested ISRS base-line audits for Ffestiniog and Dinorwig later than most of NGC. Base-line audits were respectively undertaken at Ffestiniog in December 1993 and at Dinorwig in January 1994 (ISRS 1993 and 1994). Both locations achieved an ISRS Standard 5 (S5) rating, which is exceptionally high compared with base-line audits in most organisations and was as high as any base-line scores in NGC. The detailed audit reports included a substantial number of recommendations which are broadly similar at both sites.

By January 1995 little progress had been made in the implementation of the recommendations. The only person at Dinorwig and Ffestiniog with any knowledge of ISRS was the Plant Manager who had attended an ISRS course for managers arranged by NGC Group. The only recommendations from the base-line audits which had been implemented were those requiring no significant effort or commitment. A simplified policy statement and simple general safety rules had been produced and displayed, both derived from model documents supplied by NGC Group. Recommendations for Dinorwig which had not been implemented included:

- No ISRS standards had been produced (models supplied by NGC Group)
- No Safety Management Manual had been produced (model supplied by NGC Group)
- No supervisors or managers were involved in monitoring or auditing.
- No formal incident investigation procedure existed and no follow up procedure.
- Although a procedure for managing emergencies had been produced, it had not been issued.
- Supervisors were not required or trained to inspect PPE (although some inspections of harnesses were carried out).

- No structured survey of occupational health hazards had been undertaken (although the most significant hazards were already covered by procedures.)
- Task instruction training had not been done.
- Poster targeting had not been done.
- No safety survey of items in stores or purchased had been undertaken.

Recommendations for Ffestiniog were similar and also unimplemented but in addition:

- No planned general inspections were done.
- No regular workplace inspections were done.

A safety plan called for by the ISRS audits had been prepared but was largely unimplemented. The General Manager had set an ISRS target for 1994/95 which was, on the advice of the Group Safety Advisor, to consolidate the S5 score. In summary ISRS was not implemented in any true sense within PSB and knowledge and involvement in ISRS resided mainly with the Plant Manager. Because of the general lack of knowledge about ISRS, the effect was that most managers and staff were subjected to the procedures rather than participating in them. No safety management system is likely to be effective in such circumstances.

8.4.3 Emergency Procedures

Emergency evacuation procedures were in place at both Dinorwig and Ffestiniog and practice evacuations were undertaken at regular intervals. Such an evacuation was observed at Dinorwig. It was initiated without notice by the Plant Manager and was carried out effectively with some minor qualifications. Some contractors mustered to the wrong point, one member of staff passed the gate and entered site whilst the alarm was sounding by weaving around the half barrier and the gate house security staff were unable to produce a computer listing of staff on site.

A full-scale exercise with the fire brigade took place at Dinorwig during the research period. The exercise involved five dummies to be rescued and the use of smoke bombs. Although the Plant Manager wished to simulate a real emergency, with those involved knowing as little as possible in advance, the Fire Authorities had briefed the officer in charge of each appliance, to the extent that their pre-conceived ideas of what to expect caused confusion during the exercise. The researcher was present during the de-briefing

session which revealed an excellent level of friendly co-operation between the station and the Fire Authorities but the discussion also revealed a poor level of understanding of the most basic details of what to do, where to go, how to communicate, agreed nomenclature, identification of senior officer and shift production engineer. Although previous major exercises had been undertaken, it was difficult to believe that the discussion was not taking place after a first uncoordinated trial. The exercise had taken place at the instigation of the Plant Manager who was determined to move the Fire Brigade towards a better organised and managed approach.

8.4.4 Security

PSB security is in the charge of a former Chief Inspector of police who confirmed that new employees were vetted carefully and that he attended pre-contract meetings with contractors to indicate PSB's security requirements. Several prospective contractor's employees had been vetoed and that three persons had been arrested for theft from PSB premises. Periodic stop and search operations were carried out at Dinorwig but not at Ffestiniog where there was said to be some resistance. The Head of Security was intending to introduce periodic stop and search at Ffestiniog. Further advice on terrorist attack was taken after the Warrington IRA bombing and measures had been agreed with PSB management. The Head of Security agreed that Dinorwig was vulnerable to a specific form of terrorist attack and that existing measures would be inadequate to prevent attack and escape. A considered decision had been taken that the counter-measures would not be further reinforced both in view of an improved political climate and to avoid drawing attention to the risk. He did not undertake a systematic audit of security.

It was noted on two separate occasions in the Dinorwig control room, that people were seen on the TV monitor on PSB premises, (in one case ramblers, in another case contractors maintaining the remote cameras) and although security were aware, they failed to inform control room staff. The overall impression given by the security operation was that it seemed theoretically good but in practice seemed to border on complacent.

8.4.5 Personal Protective Equipment

Although mandatory hearing protection signs were displayed in certain areas at both Dinorwig and Ffestiniog staff were observed (including a safety representative), at both sites, not wearing hearing protection where it was clearly required, not only by the signs but by virtue of the noise level. At Dinorwig the situation is complicated by the fact that it is accepted that hearing protection is not necessary for short dwell times even where mandatory signs are posted. This makes practical enforcement impossible. At both sites, staff and contractors were observed not wearing safety helmets in areas where helmets were mandatory although it must be said that in general, wearing of helmets was the norm. Non compliance was observed in areas open to public view.

8.4.6 General Risk Assessment

Very few staff interviewed had any appreciation of risk assessment or the legislative requirements. This was in spite of the detailed documentation and advice issued by NGC Group at the time of the implementation of the Management of Health and Safety at Work Regulations, Manual Handling Regulations and the Display Screen Equipment Regulations. Senior Managers and senior engineering staff were almost all ignorant on this subject and had seen no guidance. It should be noted that this situation was changing during the period of the study, by the end of which there was a much greater general awareness of the need for risk assessment. During several meetings, discussions were observed of a number of subjects, in which the need for a risk assessment approach was obvious. These included the use of BA sets at Ffestiniog, the fitting of RCDs to certain circuits and the installation of additional lighting in specific areas. It must be said that questioning by the researcher was influential in causing a number of individuals to be sent on risk assessment seminars.

8.4.7 Risk Assessment Applied to MIV Bearing Change

During August and September 1994, the bearings were changed on one of the Main Inlet Valves (MIVs) at Dinorwig, using a novel technique developed within PSB with the involvement of the suppliers of the valves. The technique provided substantial commercial savings to the Business but was technically challenging and involved a meticulous approach to the management of very considerable risks. This technique had never previously been used anywhere in the world and therefore it had commercial potential far beyond the immediate benefit to Dinorwig. A full description of the

procedure is provided in Appendix A, which is a case study of the PSB approach to the management of risk during the project. The technical details of the procedure are given in Appendix A and are not repeated here but a brief account of the significance of the project is provided below.

8.4.7.1 The Significance of the MIV Bearing Change Project

As described in section 3.7.2, the water intake to each of the 6 turbines is controlled by a 2.5m diameter main inlet valve. When closed, the valves hold back a head of water of approximately 500m at a pressure of some 80 bar. Operating experience had indicated that the trunnion bearing liners had become worn and would need to be replaced. (See Appendix A and Figure 12 for an explanation of the construction of the valve.)

The conventional way of undertaking this work would be to de-water the station by isolating the top reservoir and draining down the HP shaft (the dry method). This would mean the station would be out of commission for the duration of the work. The draining down would also have to be done slowly to avoid damaging the shaft by water pressure imploding the concrete lining. The process of de-watering, bearing replacement and re-watering would take more than 4 weeks, during which time the station would be producing no income and would be unavailable to the Grid. This latter consideration was of concern to a business that was eager to emphasise the indispensable nature of the immediate response it could provide. Much effort was therefore expended on developing a method of replacing the bearings with the station still in commission, by closing the valve, clamping it securely in position and then withdrawing the bearing assembly (the wet method). Appendix A describes how this was done and the detailed approach to the work.

8.4.7.2 Comment on the MIV Bearing Change Procedure

The project to remove MIV bearings without de-watering the station clearly demonstrates part of the cultural change in PSB following privatisation. This was one of the many instances in which PSB was striving to use every opportunity to maintain a commercial "edge" on their competitors. It does seem inconceivable that the CEGB would have undertaken the development work necessary to achieve the successful outcome of the wet method. PSB however was now in very real competition with the other generators and the total non-availability of Dinorwig for the period necessary to

adopt the dry method would have enormous consequences both in direct loss of revenue and perhaps even more importantly, in the perception of Grid System Management, of the "essential" nature of the pumped storage facility.

The high value of savings inherent in the wet method, as well as the commercial potential for the application of the procedure elsewhere in the world, ensured that this would be a very high profile project attracting considerable senior management attention. From a technical and safety aspect the work was to take place on the most sensitive part of the plant. The MIVs and the high pressure penstocks are by far the most significant areas for potentially catastrophic consequences if something were to go seriously wrong.

Any breach of containment downstream of the MIVs could be controlled but certain failures at or upstream of the MIV, would be extremely difficult or impossible to contain, leading to uncontrollable flooding and evacuation of the station. Consequently for a combination of commercial technical and safety reasons, the project had the highest possible management profile.

It is against this background that the approach to the management of risk must be considered. If this project were not managed with great care and professionalism then surely nothing else would be. In fact the approach does seem to have been cautious and systematic, with meticulous attention to detail. The development of the procedure took place over an extended period and harnessed all the essential sources of knowledge from the designers, operators and craftsmen through a combination of consultancy contracts and teamwork within Dinorwig. Great attention was paid to the integration of design and development experience with operating and craft experience, from the outset. Safety and practical considerations were therefore moving in parallel with the technical development. Great attention was paid to training and keeping not only the team informed but other groups within the business. The development using computer based finite element analysis, was very elaborate and confirmed empirically at every significant stage. Considerable thought went into the engineering of the new components not only from the functional aspect but also from the aspect of materials handling. Elaborate efforts were made to simulate the removal of a bearing and machining of a liner with life size mock ups. At all stages the approach was to identify

what could go wrong and devise a means of securing the situation if it did. Pessimistic and conservative assumptions were made on many aspects of the procedure. The method statement was the subject of continuous development prior to and after the 1993 trial which was itself an essential part of the development process. The whole approach was subjected to an external professional assessment by a third party prior to undertaking bearing removal.

From a technical point of view the approach to risk assessment for this project may be exemplary but the actual risk assessment remained a purely technical matter, with no assessment of the probability of human error. It could be argued that the precision with which the procedures were specified, including the supervision and quality control aspects, provides a means of controlling such risks but the fact remains that no specific allowance for human error was taken into account in modelling the problem.

The replacement of the MIV bearings was almost begun before a formal risk assessment was prepared. The detailed development of the initial MIV bearing removal procedure was undertaken at a time when risk assessment was largely unknown to most PSB staff, including senior staff. In the judgement of the researcher the formulation of a risk assessment into documented form and the obtaining of an external risk assessment was probably at the request of the General Manager, for his own comfort and followed separate discussions on this subject between the researcher and the General Manager and the Engineering Manager.

8.4.8 Internal Audit

It was noted that a quarterly audit of safety documents was carried out at Dinorwig and an annual audit at Ffestiniog. No systematic audit of general safety or of technical safety issues was undertaken at either site, although at Ffestiniog, a six-monthly inspection of tools and equipment was undertaken by the foreman. At Dinorwig engineers carry out safety walks on the basis of a computer generated programme and complete general check-lists on what they find. The researcher accompanied an engineer on one such walk which was a very perfunctory inspection which failed to identify poor housekeeping issues, planks on floor, equipment left in switchroom etc. The engineer

had received no training on how to complete the inspections and the system therefore was ineffective, allowing a continuation of existing poor standards.

Where safety related procedures exist in PSB they are well-written and technically sound although there are significant procedural gaps. Compliance with those procedures is generally good but there are by no means universally adhered to or enforced, making overall performance in this area no more than moderately good and far from excellent. No significant attempt has been made to adopt the ISRS approach.

8.5 Site Observations

8.5.1 Introduction

This section records observations of working conditions made during site visits and some observations of working practices. Of the three PSB sites, Bala House merits and receives least attention. It is a modern, well-equipped and spacious, open-plan office which is tidy and well-ordered. It is an excellent working environment in most respects and certainly in respect of safety. Issues concerning Dinorwig and Ffestiniog are dealt with below.

8.5.2 Safety Rules

The Safety Rule procedures are examined in section 7.5.3. This examination indicated a highly disciplined approach to the management of safety but the following site observations tended to undermine this image:

1. The job card system is designed so that before issue, the card are routed through a Senior Authorised Person who should assess the work and indicate in a space provided on the job card, whether or not a Safety Document will be required. It is not acceptable to leave the space blank. This is designed to avoid the dangerous situation in which work which should be covered by a Safety Document is initiated inadvertently, without such a Document having been issued. It was observed and was readily acknowledged by the engineers and supervisors, that this requirement was generally ignored and the space was normally left blank. The justification seemed to be that the supervisors themselves were sufficiently knowledgeable to make the assessment.
2. When work is to be performed on mechanical plant and the safety precautions involve isolation, the Rules require that a Permit for Work is issued. It was noted that in these circumstances a Permit was rarely issued. (e.g. for small mechanical items such as

pumps.) An instance was also noted, of work being authorised on electrical excitor gear without a Safety Document, when one was required by the Rules. The justification given for this, was that the work was being done by shift craftsmen who were well known and trusted by the shift engineers initiating the work. As one engineer put it, *“In small teams, Rules are bent, a fitter can isolate, re-energise and test if the shift engineer knows him. The Rules should be changed to accommodate this.”*

N.B. It must be noted that steps have been taken to regularise the position by the issue of a GP 3 procedure although this relates to the period after the observations made above.

(Engineers emphasised that H.V. safety precautions would always be applied by or under the direct supervision of shift engineers.)

3. It was noted that one CEGB Permit was still locked in a card safe in the permit office at Dinorwig, six years after the CEGB rules were withdrawn. It was also noted that the plastic encapsulated diagram of a Permit displayed in the permit office at Ffestiniog (intended as an example of correct document completion) was a copy of a CEGB Permit.

4. A senior member of the engineering staff at Dinorwig expressed concern over standards of safety at Ffestiniog and cited examples of where he believed mistakes had been made. This was put down to the *“variable quality of the Senior Authorised staff at Ffestiniog”* who were *“old, staid and had been there too long.”* The variable quality of the Ffestiniog shift engineers was supported by another Ffestiniog engineer who, when accepting a Sanction for Test would *“double check especially if the shift engineer looked harassed.”*

8.5.3 Housekeeping

Both Ffestiniog and Dinorwig were originally designed as good, well-planned working environments with relatively spacious accommodation although obviously, at Dinorwig, the nature of the underground location resulted in space restrictions. At both sites the most obvious issue was the generally poor standard of housekeeping. Both sites were open to public visits and it was obvious that standards were higher in parts open to public view. At Dinorwig there was evidence of recent expenditure on painting and marking of floors and roadways, particularly in parts seen by the public but other areas told a different story. The tail gate area contained items left about with no obvious sign of future use. A new stores building had been erected to accommodate items from a

store at Llandegai, some five miles away, which was being closed. The racking in the new stores was incomplete and there were signs that the situation would improve when the new stores was finished but items had been placed out of sight around the outside of the stores building. The transformer bay area underground was very cluttered by cable drums, steel plates pallets and heavy engineering components in spite of notices such as "Keep clear, Exit from Emergency Escape". The exit from a Generator Motor Transformer was blocked completely by a large skip.

The underground 415v switchrooms, some of which had very dirty floors, were used as dumps for all manner of items, including old cables, electrical components, fluorescent lamps, Halon bottles, zip-up scaffolding, cardboard boxes, filing cabinets crammed with documents on broken, leaning shelves, old manuals, desks, pallets, fire-extinguishers, old doors, glass cabinets, old pipes and hardboard. A telecommunications room was similarly cluttered. In some cases it was obvious that the items had been placed there deliberately and perhaps with the intention of future use. In other cases items had been put out of sight and many items were debris which had not been cleared up after a job. Certain items represented additional flammable material in the event of a fire, all of the unnecessary items would represent an additional hazard in the event of smoke whilst the levels of dust in some switchrooms must represent a maintenance hazard in relation to electrical switchboards and equipment.

Cable flat doors were left open and there were piles of discarded scrap cable and glands in cable flat areas. The stores area, which had recently been extended was quite tidy but with some rubbish on the higher racking areas and very tall and unstable stacks of cardboard boxes. The electrical workshop and control and instrumentation rooms were extremely untidy with swarf, cable drums and other items set down anywhere with little semblance of order and every level surface used as a storage dump.

In contrast, some areas demonstrated a good standard of housekeeping such as the main mechanical workshop (where the foremen's office was located). This was clean, well lit, spacious with a recently painted and well-maintained floor. With the exception of items stored on the tops of some lockers, the standard of housekeeping in the workshop was excellent. Housekeeping in another mechanical workshop (54m level) was very good, although swarf had been left around a lathe and not cleared up. An electrical workshop

where HV switchgear was maintained was tidy and spacious representing an excellent standard.

A major project was underway to fit a false roof to the machine hall cavern. The drips caused by seepage through the slate roof were causing discolouration and spoiling the appearance of the synthetic floor surface. The work involved fitting roof supports for the roofing panels and fitting inspection walkways to the roof. A large quantity of components were stored on the machine hall floor which had first been covered with hardboard for protection. It was intended that clear walkways would be left through the machine hall but the clear walkways were themselves obstructed and congested. Housekeeping standards at Ffestiniog were similarly better in the parts of the station seen by the public but standards in most of the rest of the station varied from good to very poor.

A new outdoor stores compound had been built but when visited after rain it was found that the concrete plinth was largely covered by one to two inches of water. Items stored on the plinth included scaffold boards, pipes, cable drums and other large engineering components. They were stored untidily and often in an unstable way and after rain, were standing in water. The outdoor compound, in this state, seemed almost designed to extinguish any pride in the site. The electrical workshop was very untidy. The battery room was damp and untidy with old lockers and other items stored there. The lockers were obstructing the eye-wash bottle, the bench was cluttered and there were no rubber gloves. The diesel room contained a pile of rags in a corner, an obvious fire hazard and an electric lead was resting on a heater before going out through a louvered window. An abrasive wheel in the tool store was surrounded by clutter. A hole in the floor outside was covered by a plank. The LPG store was open with an oxygen cylinder next to LPG. Although specific ladder racks were provided, ladders were found all over the station. (It was noted that all ladders seen were nevertheless within their inspection dates.)

The picture was not one of unrelieved gloom. The machine hall was used to store engineering items and was normally quite well-ordered although a large roller shutter external door was frequently open and used by fork trucks, which caused the floor to be wet and dirty in inclement weather. On an initial visit, the mechanical workshop was found to be untidy with swarf all over the floor and heavy items stored badly against a

wall, although on a later visit it was quite tidy. It was apparent on one visit, (17/10/94), that a considerable effort had been made to tidy the visible parts of the site

The stores was found to be tidy. It was noted that the stores was to be refurbished and that the storekeeper had been consulted in drawing up the plans for new racking.

All interviewees at both stations readily acknowledged that housekeeping standards were poor. The General Manager emphasised his personal concern at every opportunity and he was regarded by some engineers and supervisors as “*obsessed with tidiness.*” It was clear, at both sites, that where things had improved it was largely as a result of his personal intervention but it seemed that it was only his personal intervention that would have any effect. The result was that money was spent on smartening and tidying the environment but this was clearly tackling the symptoms not the disease. Other line managers emphasised their concern at HESAC meetings and in line management settings. Supervisors claimed that they had little or no time for supervision due to paperwork and that lack of tidiness was due to inadequate staff numbers. They also blamed engineers for not throwing things away. It was suggested that at Ffestiniog, many items had been retained as a result of a belief that spares could help to ensure the longer term survival of the station in a climate in which major capital expenditure on an old station would have been uncertain. Staff themselves claimed that time pressures resulted in poor housekeeping. It was clear that the bulk of the examples of poor housekeeping were the result either of items being deliberately put in an inappropriate place or not being removed at the end of work. In either case, the argument of insufficient time was unconvincing. At both Ffestiniog and Dinorwig examples of excellent housekeeping and concern for the environment coexisted with a background of a very poor housekeeping and a lack of concern for the environment bordering on contempt.

8.5.4 Use of Personal Protective Equipment

In both the mechanical and electrical workshops and the welding workshop at Ffestiniog, pedestal drills were unguarded and with no clamp fitted. In the electrical workshop an abrasive wheel which was heavily rutted, was not marked with its RPM. At both Dinorwig and Ffestiniog the norm was that safety helmets were worn where mandatory but this was not universal and it was observed that hearing protection was not always worn where it was mandatory. At Dinorwig the situation was complicated by the fact that management accepted that hearing protection was not necessary in

mandatory hearing protection zones, provided the duration of a stay was short. Thus a mandatory sign was rendered meaningless.

One fitter reported that he had always worn safety spectacles in his previous employment but was told that this was not necessary when he joined PSB. The following week when he was climbing a ladder a piece of metal, which had been dislodged by a fitter above him, fell into his eye. He required hospital treatment.

8.5.5 Working Practices

In most cases, workers were found to be properly equipped and working safely but a number of instances were observed when this was not the case. In one instance, two fitters at Ffestiniog were about to burn steel plate with a cutting torch, in the indoor oil store, when they were stopped by the foreman. Another example, at Dinorwig, was an instance in which a fork truck was being used to move several tall Halon 1301 bottles up a ramp into the outdoor store, mounted on a pallet. One man was holding the bottles, which were very heavy and unstable. An engineer at Dinorwig was observed using a hacksaw blade in an unsafe manner, modifying a volt meter module, on the control room desk.

8.5.6 Other Observations

A good attitude was displayed at Ffestiniog when "Caution Wet Paint" notices were used as improvised notices to warn of trailing cables. At Dinorwig the "Scafftag" system of marking was noted to be rigorously observed and fire points seemed to be well maintained. Supervisors were observed paying attention to work activity which may have proved particularly difficult.

8.5.7 An Example of Work Activity

The isolation and earthing of No.3 machine at Ffestiniog was observed in detail. This involved using the overhead travelling crane to lift heavy floor sections exposing the bare 18KV connections from the generator. The connections then had to be tested and earthed before a Permit-for-Work could be issued. Lifting eye-bolts had first been placed in the floor sections and formed substantial tripping hazards until a barrier was erected around them about an hour later. When the first section had been lifted the barriers themselves became a hazard as they were too close to the hole and the fitter

working inside the barrier had insufficient floor space to work safely. Lifting chains attached to the crane hook were lying on the floor adjacent to the unfenced hole and could easily have been caused to fall into the hole and make contact with bare exposed 18KV copper conductors which had not yet been proved dead. The testing instrument was tested before and after use as required by the Safety Rules but the operation of the voltmeter needle, although positive, was far from being unmistakable. Two Senior Authorised Persons were involved in this job, the Shift Charge Engineer and a spare shift engineer. It was not certain that one person was in charge of the total operation, a fact which annoyed the Shift Charge Engineer who felt that the other engineer was interfering, although in fact he was trying to be helpful.

8.5.8 An Example of Crisis Management

The handling of an operational crisis at Dinorwig was observed when penstock resonance occurred. The Shift Production Engineer (SPE) went to the MIV gallery immediately to deal with the problem, taking engineering drawings with him (which were not of the first quality in terms of legibility). The problem was that the service seal on No.5 MIV would not stay on. Every time an attempt was made locally (at the MIV) to apply the seal, violent penstock resonance occurred with rapidly increasing frequency and amplitude. The noise of the resonance was alarming to those present but the SPE maintained a calm logical approach in attempting to apply the seal, causing resonance to recur at each attempt, before finally leaving the seal off. There was a leak on the hydraulic system which applied pressure to the seal. The seal began to apply but the leak resulted in the pressure of application being unable to overcome the MIV water pressure and the seal was therefore forced off. It attempted to come on again only to be forced off again, thereby causing severe resonance.

The SPE had noted a leaking seal resulting in water in a tundish and he checked the operation of the two valves that were the usual cause of the problem before trying to close manually. He used alternative hydraulic supplies before abandoning attempts to apply the seal. He explained all his actions to the fitters with him. As a temporary measure an orifice was drilled out to provide enough flow to overcome the leak and the unit was used that night for pumping before being taken out at 05.00 hours the following morning for a permanent repair. This was an excellent example of a

professional approach to an operational crisis and displayed competence and effective teamwork.

8.6 Public Safety

8.6.1 Visits By The Public

Both Dinorwig and Ffestiniog sites are open to guided visits by the public during the main holiday season. The researcher joined visits to each site at an early stage in the research before he became known to the staff.

At Dinorwig the visit began in the nearby Museum of Wales with a static exhibition and audio-visual presentation. The party (comprising 40, 12-year old students, four teachers and the researcher) then joined a mini-bus manned by a driver and guide, for a tour of the station. Cameras were surrendered into lockers for security reasons prior to departure. The guide emphasised the importance of safety briefly but effectively and the need for the party to keep together. The party were issued with and expected to wear, safety helmets. The bus stopped at the gate for the guide to inform security of the number of persons in the tour. The party disembarked at the MIV gallery and walked up to the machine hall before returning to the bus which then took them to a viewing gallery which overlooks the length of the machine hall and in which a further audio-visual presentation was made. The guide and driver were at the front and rear of the party at all times. The bus returned the party to the Museum at the end of the tour. Stationary buses displayed a yellow flashing light to warn station traffic that pedestrians were in the vicinity. The visitors' route was well delineated with no significant safety hazards although the party passed close to a ladder which was lashed close to the rotating unfenced vertical turbine shaft. The route also passed mandatory ear protection signs although visitors were not expected to use ear protection. It was later established that the justification for not insisting on the use of hearing protection (both for the public and for staff) was that the dwell time was insufficient to cause a problem on the prescribed route. The impression was of a well-organised and controlled visit to a neat, tidy, well-ordered workplace with proper attention paid to safety with the slight qualifications made above.

At Ffestiniog the tour began in the adjacent visitor centre with an audio visual presentation and description of the station given by the guide. Visitors were taken to the

station in an electric (battery operated) minibus driven by the guide. The visit toured part of the station on foot on a predetermined route and was well controlled by the guide who emphasised safety, safety helmets being issued to and worn by the party. It was noted that one fire door in the stairway would not close and that the minibus was in need of refurbishment, the wooden floor being worn. The minibuses in use were ex-Dinorwig. The impression gained was of an informative tour of a reasonably well-ordered site but the age of the visitor centre, the minibus and to some extent, the station, provided an altogether less polished visit than at Dinorwig. The chief guide at Ffestiniog complained of the state of the buses and of “*hand-me downs from Dinorwig*” and was frustrated because of cost pressures which made it difficult to get PR material. In view of the fact that many visitors visit both sites it was perhaps surprising that the Chief Guide at Ffestiniog had not seen the recently introduced Dinorwig audio-visual presentation.

Maximum numbers of visitors per tour had been set for each site (50 at Dinorwig, and 7 at Ffestiniog) and guides have been briefed on security issues. It was noted that guides have alerted the security officer to suspicious behaviour on two occasions although in each case it had been a false alarm. All buses were fitted with radios.

8.6.2 Fatal Accident To Member Of The Public

In 1991 a member of the public fell to his death in old mine shaft with an entrance close to land owned by PSB. There are many similar old workings on the land owned by PSB and following this incident those adjacent to public footpaths were sealed with iron bars to exclude the public but to allow bats to enter.

8.6.3 Other Aspects

Lifebelts are maintained adjacent to reservoirs with public access and security staff patrol the dams and reservoirs at Ffestiniog twice a week. It was reported that children had been known to swim to an island in the middle of the bottom reservoir at Ffestiniog. Staff from Ffestiniog had visited local schools to speak to children to warn them of the dangers of such activity.

The overall impression at both sites is that PSB are very conscious of their responsibilities for public safety regarding both invitees and trespassers and take reasonable precautions commensurate with the risk.

8.7 Safety Performance

8.7.1 Objective Measures

The only objective measures of safety performance in PSB were the accident frequency rate (AFR) and ISRS audit scores. The ISRS audits, which are referred to in Section 7.9.2, resulted in S5 standard at both Ffestiniog and Dinorwig, which was as good as any other assessed management units in NGC. The ISRS approach is heavily biased towards the existence of procedures with rather less emphasis on their effectiveness. At the time of data collection, the AFR for PSB did not discriminate between the various sites but was a composite figure for the whole of the Business based on lost time accidents divided by man hours worked x 100,000.

With a work-force of only 200 the AFR as a performance index is vulnerable to large variations in the event of a small number of lost-time accidents. The index is used as a moving average which therefore means that it takes 12 months before the effect of a particular accident is lost on the AFR. Within PSB and within NGC, AFR is acknowledged to be a poor indicator of safety performance. The AFR for PSB in April 1994 was 2.60, an historically high figure, largely due to seven lost time accidents occurring in August to October 1993 (five at Ffestiniog, two at Dinorwig). The AFR target for 1994/95 was set by PSB management at 0.8 which had been the target for 1993/94, based on a March 1993 figure of 1.08. By the end of December 1994 the AFR had reduced to 1.1 and would reach the target of 0.8 if there were no lost time accidents from January to March 1995. (Other privatised generating companies have achieved AFR figures of the order of 0.2 but with much larger manpower bases they are not subject to the same statistical variations.)

The 1994/95 PSB Business Plan set safety targets as follows:

“Objective - Seek to achieve an AFR of < 0.8 and strive to minimise the incidence of all types of accidents and losses

Strategy - Constantly monitor working practices and ensure good housekeeping to prevent dangerous situations which may lead to accidents, and consider the benefits of the ISRS system and implement where beneficial.”

It was noted that although some attempts are being made to benchmark PSB with similar installations, no specific attempt has been made to make benchmark comparisons on safety performance.

8.7.2 Individual Accidents

Examination of the Accident Reports for the lost time accidents from October 1993 to January 1995 indicates that most incidents were trivial in nature with trivial consequences e.g.:

- Caught thumb on locker whilst reaching inside.
- Caught back of heel on underside of step when getting out of bus.
- Missed door step when entering portable mess-room, knocking shin.

Such incidents may indicate that there is scope for managing absence as well as managing safety.

Some incidents were potentially more serious e.g.:

- The driver and passenger in a new lorry were injured when it moved back violently into the tunnel wall resulting in fractured ribs. This incident was almost certainly the result of the driver inadvertently engaging reverse gear, since reverse gear on the new lorry was in the same position as first gear on the previous lorry. The driver would not admit to this, but it transpired that another driver had made the same error some weeks earlier but without incident and had not reported the event.
- Side of cable drum collapsed as it was being rolled to remove cable resulting in crushed fingers. The cable should have been withdrawn by using drum supports and rotating the drum.

Major incidents which had occurred in the past included the following:

- A walker entered a disused mine shaft and fell to his death. See section 8.6.2.
- A flashover occurred as a circuit breaker at Dinorwig was being racked from the isolation to service position because the circuit shutter failed to open properly. Emergency procedures were followed correctly and the fire was contained and

extinguished with limited injuries sustained by those adjacent to the switchgear at the time of flashover.

- A helicopter crashed into the top reservoir at Dinorwig. The pilot and passenger escaped and swam ashore but the risk that parts of the helicopter might be taken into the high pressure system was very real. It transpired that the helicopter had settled on the edge of a ledge on the reservoir bed and it was recovered safely without further damage.
- During maintenance at the Dinorwig head-works, a scaffold pole (aluminium) was dropped vertically, penetrating a safety net. It was not recovered and it was concluded that a 2m aluminium pole could be ingested by the turbines without causing serious damage. Pieces of the pole were found at the next time one of the tail races was opened for inspection.
- A pump at Ffestiniog was inadequately isolated and the control engineer at Ffestiniog operated in such a way that the pump was started at the request of Grid Control causing rapid de-watering of the HP shafts. No damage resulted.

Although certain of these incidents are low probability events they serve to highlight the vulnerability of the PSB plant to serious loss exposure.

8.8 Other General Issues

8.8.1 Introduction

During the research, data were obtained on a number of areas, which were not directly related to safety but which could influence staff perceptions and attitudes, as well as relationships, both within PSB and towards NGC. This section comprises a record and analysis of such issues.

8.8.2 Staff Target and Review Scheme (STARS)

During 1994, PSB introduced the Staff Target and Review Scheme (STARS), which was designed to produce individual personal performance targets for all employees and an assessment of performance against those targets. Each employee was to submit a form on which they had identified their key targets for the following year, based on guidance contained in an information pack previously issued to all employees.

Employees would also indicate on the form how they believed they had performed in key competency areas and propose, in another section of the form, a personal development plan. Employees had to give the form to their line managers prior to a review meeting between the line manager and the employee. At this meeting the

reviewer would add comments and then targets, performance assessment and a development plan would be agreed as well as an action plan. All agreed and completed forms would then go to a moderator for approval before being returned to the Personnel Department. The STARS scheme also provided for failure to agree and for access to the Company Agreement Grievance Procedure. The key competencies identified in the scheme were:

- Professional/Technical Skills and Knowledge
- Communication Skills (written and verbal)
- Interpersonal Skills
- Personal Organisation Planning
- Decision Making and Judgement
- Teamwork
- Flexibility of Approach to Work/Innovation
- Customer/Service Awareness
- Safety/Security Awareness

The stated objective of the scheme was:

“To enable people to develop and achieve individual excellence whilst contributing to the overall aims and objectives of Pumped Storage Business.”

Another feature of the scheme was a link to pay depending on performance against targets. The possible review ratings and associated pay linkage is indicated below:

Review Rating	Increment (where applicable)
Outstanding	1 (plus appropriate lump sum payment)
Highly effective	1 (plus appropriate lump sum payment)
Good/Improving Performance	1
Needs Improvement	0 (plus potential for early review)
Unacceptable	0 (plus potential for early review)

(Lump sum payments to be 2/3 or 1/3 of an increment.)

Interviews with staff indicated overwhelming scepticism, suspicion and misgivings about STARS. Staff representatives objected to the pay linkage arguing that it was divisive, to which management reacted by offering to remove the pay linkage (and thereby the prospect of incremental advance). The scheme was eventually adopted with

the pay linkage and therefore represented the introduction of performance related pay, for the first time, to all staff.

Comments from older employees frequently took the form: *“STARS is not appropriate to older staff” ... “I’m not convinced of its value to older staff.”* Comments were also frequently associated with the impossibility of improvement; *“There’s no room for improvement so why set targets?” ... “Everyone is doing their best now, what use is STARS?”* or the futility of the scheme; *“It won’t make any difference in motivation” ... “Where will high performers go anyway? - there are no prospects” ... “There’s no point in it for me” ... “It will take up too much management time - for what?” ... “It is more work for people who are already busy” ... “What’s the use for plodders like me?”*

Supervisors were sceptical and reluctant implementers; *“There’s nothing in it for the lads; most of them are on their top increment” ... “Staff do everything they are asked, what good is STARS?”* Another supervisor acknowledged; *“It has some good features with respect to training needs but it does not recognise loyalty, commitment or flexibility.”* Some staff emphasised the potential for division, *“A similar scheme at Trawsfynedd caused bad feeling, it might do some good” ... “The money’s not important” ... “I’m not keen, it will be divisive.”*

Some comments reflected a scepticism about management commitment, *“It’s early days and depends on management, are they for it or against it?”* Several emphasised the need for fairness; *“If it’s not implemented properly it will be bad, they must recognise ability.”* This concern was particularly acute in the Personnel function; *“It depends on the assessor setting sensible targets and not saying everyone is good. Some targets simply amount to turning up on time in clean overalls.”* The Personnel function acknowledged that staff and supervisors were unenthusiastic and in monitoring the returns, were concerned about fairness, particularly between comparable groups (e.g. shift teams) and that some of those assessed had put in much more effort than the assessors. They realised that standards were inconsistent and in some cases trivialised. Personnel intended to undertake a review of the scheme.

Exceptionally one employee said; *“It might make me think of my performance but I wish I hadn’t agreed my targets.”* A senior manager said; *“STARS is useful in bringing issues*

to attention not in motivating or setting targets. It provides an opportunity to broach issues about the use of resources and reveals the need for more training."

Personnel regretted that more time had not been devoted to helping assessors to set fair targets, particularly with manual workers whose targets were more difficult to define. The STARS scheme was a very significant focus for staff concern during the study. Staff at all levels were uncomfortable with the scheme.

8.8.3 Flotation

The prospect of the sale of NGC during 1995 by the REC shareholders and its flotation on the stock market was well known to staff. However, during the study it became known that PSB was possibly going to be de-merged from NGC during this process.

Press reports speculated about the future of PSB, either as directly owned by the RECs or sold to a third party and statements from the Director of OFFER, Professor Littlechild, emphasised his wish to see PSB split from NGC and that he was not in favour of ownership by the RECs. This fuelled staff concerns and suspicions. The General Manager held several meetings with staff representatives and much of the time at the Local Council was spent in discussion of the flotation issue. Staff representatives felt; *"Top management are holding information back,"* a statement which was clearly true but also inevitable. Most concerns centred around future job security, pension rights and also the consequences for the NGC Share Scheme members. (Those employees who had been members contributing since the start of the scheme were expecting to receive sums in excess of £50,000 if they remained in the scheme).

Although management were being as open as they could be in informing staff there was continuing substantial concern at the uncertainty surrounding serious personal concerns. The uncertainty was made worse by government delay in coming to a final decision on NGC flotation which meant that staff were told that more information may be available by the end of each month from October 1994 to February 1995.

N.B. De-merger and flotation eventually took place at the end of 1995.

8.8.4 Company Agreement and Pay Award.

Although the NGC Company Agreement was effective from March 1993, it was not popular with large sections of the staff in PSB. As one engineer put it; *“The single spine agreement is a disaster. It would have been thrown out by 90% of the staff. We would do better with a PSB agreement.”* The Personnel function confirmed that staff were *“unhappy with the new agreement especially over the cushioning payments.”*

The 1994/95 NGC salary award was unpopular with staff and when the ballot of members took place it was reported that the award would have been rejected by PSB staff but the votes of other groups in NGC ensured a small majority in favour of acceptance. Interviewees felt strongly that the dissatisfaction with the pay award was fuelled by comparison with the remuneration of Directors. Typical comments were; *“Directors’ pay is excessive and unthoughtful in awarding themselves high rises when restraint is being asked of others” ... “They should show restraint” ... “Share options are over the top, especially for the Chief Executive who has only been here five minutes” ... “Directors’ pay does nothing to dispel the greed culture” ... “The market rate argument is rubbish.”* It must be noted that although staff expressed almost universal condemnation of Directors remuneration and strong feeling against the Company Agreement and the Annual Pay Award, there was equally strong agreement that PSB provided good terms and conditions of employment and was a good employer.

8.8.5 Care and Concern.

Several interviewees including staff representatives listed examples of the care and concern exhibited by PSB towards its employees, particularly at times of bereavement or personal difficulty. One example was the provision of transport every week to enable a mother to visit her Dinorwig employee son, who was receiving treatment in a Liverpool hospital. Another tragic case involved an employee who had been on a camping holiday in France when a tent fire resulted in the death of one child and serious injuries to another which then required long term treatment. PSB were very helpful from the time of the incident and subsequently arranged a job transfer for the employee to another part of NGC so that he could live near the specialist treatment centre for the child.

Supervisors referred to staff who were “*nursed*” and PSB in general and perhaps Ffestiniog in particular, did appear to enjoy relationships akin to those of a family. An engineer expressed appreciation about a dinner arranged for his 30 year long-service award and the bouquet for his wife. The fact that PSB issued child-care vouchers was also appreciated.

One employee committed suicide during the research period and it was established that a total of three suicides, including this one, had occurred in the workforce in the last five years. It was suggested by the Occupational Hygiene adviser that he believed that working underground contributed to psychological stress and that workers were hypersensitive to welfare issues. No specific work had been done to establish stress levels and no stress counselling had taken place.

8.8.6 Induction and Training.

Although PSB had no formal policy on staff development, it operated an educational incentive scheme. Personnel confirmed that approximately 27% of staff were undergoing some form of further education.

An engineer from Dinorwig had been given the task of co-ordinating staff training (as well as being the COSHH Officer and responsible for co-ordinating safety matters). Interviewed near the beginning of the study he had appeared unclear about his role and with little motivation but when seen six months later, it was evident that he was beginning to organise more effectively. Training was taking place on amongst other subjects, fire, lifting and moving, use of overhead travelling cranes, use of mobile cranes, access platforms, scaffolding. Risk Assessment training was undertaken as a result of the influence of the researcher and a seminar was held on the CONDRAM Regulations. Familiarisation training was also initiated on the revised Safety Rules. It was evident that training records had been poor in the past and they were poor at Ffestiniog where reliance was placed on the memory of the foremen to retrieve the records which were found to be incomplete.

A senior member of the engineering staff complained that operational refresher training was not happening as it should be. Induction training was not happening at either station, in accordance with the procedure and Personnel Department staff were unaware

of the requirements of the system. Training was reduced at certain times because of pressures of outage work.

8.8.7 Communications.

Staff representatives claimed in consultative meetings and in interviews, that communication within PSB was not good and it was not surprising that rumour should flourish in view of the issues such as STARS, Flotation, De-merger, De-manning of Ffestiniog, New Company Agreement, Annual Pay Award etc. Management were clearly trying hard to communicate effectively and the General Manager regularly emphasised to his direct reports and to the staff and their representatives, his commitment to open, honest communication and his desire that the views of staff should come back to management.

PSB issued a Monthly Newsletter to all staff. The PSB Executive would produce core briefs of the ten most important issues to be communicated with an action on the members of the Executive to promulgate the information within five days. During the study, a video communication system was installed at each PSB site which conveyed current business information such as the previous day's generation, income information, outage updates, as well as safety information, sports and social events and personal information such as items for sale. The video display used excellent graphics, was interactive and could be accessed by all staff.

In spite of the efforts at communication rumour was quicker. An example was the rumour at Ffestiniog that letters were being sent to both Dinorwig and Ffestiniog containing details of the future of PSB and the letters had to be opened simultaneously at each site. The letters were simply a report of the most recent statement by Professor Littlechild. In the climate of uncertainty about Flotation it seems clear that whatever information management communicated would be regarded with suspicion and regarded as inadequate.

8.8.8 Use of External Advice.

A tendency towards self sufficiency in PSB, in particular in relationships with NGC Group, was consistent with the perception of PSB by the NGC Health and Safety functions. The Medical Officer's view was; *"They are very independent. They will listen*

occasionally to some central advice but they do what they want to do." The use of BA sets by shift staff with beards contrary to advice, was cited as an example. Headcount reductions at NGC Headquarters within the Health and Safety function, had led to repeated changes in the Group nursing officers dealing with PSB and the constant changes had caused some misgivings within PSB.

The view of PSB from the Occupational Health function was that *"if anything it is the management levels who are the ones under strain."* The Group Safety function confirmed that PSB rarely approached them for help and advice and they had no knowledge of any recent Authorisations or any operational refresher training. None of this is to suggest that relationships were hostile or difficult, merely distant.

The engineer at Dinorwig charged with co-ordinating safety matters, had attempted (unsuccessfully), the NEBOSH examinations. He attended local safety groups at Bangor and would ask advice if necessary, directly from HSE contacts at that Group.

The issues on which such advice would be sought, such as new legislation, were issues on which the Group safety function would already have established a policy position, possibly after high level contacts with the HSE. The danger of naive questions direct to the local HSE inspector was that it could possibly result in a misguided stance and do nothing to enhance the credibility of PSB or NGC.

On occupational hygiene issues, PSB had a contract with the Electricity Association, Safety Group whereby an occupational hygienist would attend site two days per month. He was well known and respected on site having been previously employed in the North West Region of the CEGB. He had maintained a relationship with Dinorwig since commissioning. He had done detailed investigations on issues such as noise, chemical safety problems as well as investigations into a phenomenon emotively referred to by the staff as *The Black Death*. The latter was a black deposit composed of diesel exhaust, carbon, concrete dust and oil mist, resulting in a black smear on surfaces. Efforts were being made to reduce oil mist by using electrostatic collectors adjacent to the source of the mist at the turbine bearings. In relation to chemical safety, traces of Genklene had been found in the bottom lake which had resulted from its use in floor cleaning operations which had subsequently been stopped. Noise surveys and subsequent advice had been provided and the possible use of anti-noise had been investigated. PSB were

well served by an excellent source of occupational hygiene advice although this was not necessarily any assurance that the advice would be applied in all cases at the shop floor.

8.8.9 The Influence of the Researcher

It has to be acknowledged that the periodic presence of the researcher, over an extended time, in a small organisation, influenced the course of events to some degree. In a limited sense therefore, the data obtained will have been unavoidably contaminated by the activities of the researcher. An acknowledgement of the special circumstances relating to this issue is made in the opening statement to this thesis. Reference is also made to this in Appendix C, which represents a report of preliminary discussion, conclusions and suggestions, which was presented to the host organisation during the research period at their specific request.

The fact that the researcher was employed as the NGC Group Safety Advisor until April 1994, was known to many staff and helped in establishing the credibility of the researcher and gaining the confidence of interviewees. Another consequence was that the advice of the researcher was sought several times during the study and was freely given but only in response to requests. The questioning of interviewees occasionally drew their attention to matters of concern and from time to time probably influenced events and behaviour.

At the beginning of the study there was little, if any, appreciation of risk assessment at Dinorwig and Ffestiniog but questioning on the subject undoubtedly raised awareness and influenced the fact that staff at both sites attended risk assessment courses. It is also likely that the commissioning of an external risk assessment on the MIV project, was prompted by discussions between the researcher and senior staff (see section 8.4.7.2). Advice issued by the Group safety function on the "Six-pack" legislation was not in evidence at Ffestiniog but questioning on the subject prompted enquires which led to Ffestiniog receiving and beginning to act on the advice. Questioning on the safety of visitors and on the form taken by Safety Rule audits, prompted the Production Manager at Ffestiniog to plan these matters differently. Poor housekeeping standards were discussed with supervisors, at both power stations during site inspections. This raised awareness and probably prompted action in certain cases, to improve the situation.

Individual members of staff asked for and were given, advice in relation to the Safety Rules and other aspects of the work they were doing.

These examples illustrate that in a limited sense, the data obtained, prior to the issue of the first questionnaire, are likely to have been contaminated by the activities of the researcher. Following the collation and analysis of data after the issue of the first questionnaire, the researcher produced a report for management, at their request. This was considered and accepted by the Company and will inevitably have had some further influence on the developing the situation.

Chapter 9

EVALUATION OF THE PSB SAFETY CULTURE

Part 3 – Development and Use of the Safety Culture Questionnaire

I grow daily to honour facts more and more and theory less and less. Fact, it seems to me, is a great thing – a sentence printed, if not by God then at least by the devil.

Thomas Carlyle 1795-1881

9.1 Introduction

The starting point for this study was the third ACSNI report (HSC, 1993), in which there is a prompt-list of factors which research evidence identifies as being indicators of good safety performance. (The prompt-list is reproduced in Appendix D). An account of the data collection process using site observations, informal discussions and structured interviews is provided in Chapter 6. Efforts were made during that process to determine the status of PSB in relation to the ACSNI factors. However, site observations and interviews are resource intensive in respect of the researcher, as well as being intrusive in respect of the organisation being studied. A questionnaire was therefore developed with the following objectives:

- To seek the views of as large a sample of staff as possible and thus maximise the amount of data obtained.
- To provide objective data to support or refute the more subjective conclusions drawn from the techniques already employed.
- To obtain as much data as possible in relation to the factors identified in the ACSNI prompt list as being indicators of a good safety culture.

The use of a questionnaire also allows statistical analysis of the responses although it was recognised at the outset that it was likely that such analysis would be limited by the small population involved in the study. Nevertheless it was intended to use the techniques of analysis of variables and factor analysis insofar as this was practicable. The questionnaire would also provide a measurement tool which could be used again on a later occasion to determine the extent to which the safety culture had changed. It was

assumed that the external context of PSB would continue to change for some significant time and it was hoped to be able to use the questionnaire again after approximately two years.

9.2 Development of the Questionnaire

A reasonably accurate judgement may be formed about some of the prompt-list factors by direct observation e.g:

"2.1.3 A positive commitment to safety is visible throughout the management chain?"

Nevertheless a questionnaire may be useful to seek wider views on such a topic.

Some of the factors in the prompt-list refer to procedures which may or may not exist in the organisation. e.g:

"2.3.6 Has the organisation introduced incident investigation procedures which..."

The applicability of such factors may be readily determined by direct questioning and verified where appropriate. A questionnaire is an inappropriate tool for obtaining data on such factors.

Other factors relate to the under/over-estimation of risk. e.g:

"Managers, supervisors and other personnel may tend to underestimate the magnitude of risks:

(a) with no significant potential..."

It would not be possible to determine the status of the organisation in relation to these factors without a study of actual risk levels in specific activities and comparing the results with individual perceptions of risk. No study of specific risk levels was undertaken and the questionnaire therefore did not embrace these factors although a number of questions were included which were intended to explore individual attitudes to safety. These questions were based on a questionnaire previously used by Jansen and Thomas (1994), in a study of railway workers.

Many other factors in the prompt-list relate to views and attitudes which can be most effectively tested among a large group by the use of a questionnaire. e.g:

"1.1 Communications at all levels are founded on mutual trust."

A draft questionnaire was then produced, which was to be subject to validation before a final version was prepared. The draft was based on the objectives in 9.1 and taking into account the qualifications noted above. (The final version of the questionnaire and

covering letter are reproduced in Appendix E.) Respondents were invited to indicate their positions in relation to 51 statements against a nine point Likert scale, ranging from a value of *1-strongly disagree*, to *9-strongly agree*. To avoid confusing the respondents, the questions were “oriented in the same direction”. Two further questions were added which demanded factual answers. These related to the safety target and the safety performance of PSB. Two other questions were also added concerning the safety of the workplace and the attention paid to safety. These required a yes/no answer.

In order to make any meaningful analysis of the data being sought, it was necessary to have some knowledge of the type of occupation, job group and the base location of each respondent. Respondents were to be asked to indicate whether their base location was Bala House, Dinorwig or Ffestiniog as well as their job group (grade) within the company agreement. Separate categories were included for personal contract holders as well as a category for anyone who was not covered by the company agreement and was not a personal contract holder. The occupations were divided into the groups indicated in the questionnaire (see Appendix E), which included a broad division between shift and day workers. It was appreciated that if the occupations were too finely divided within such a limited number of employees, it would have been quite easy to identify individual respondents. This would probably have been perceived as compromising the anonymity that was promised to staff at the start of the study. Accordingly the occupation groups were listed in a way which was not too specific. Requesting any further personal details about the respondent, such as age, length of service or accident experience, would also have tended to compromise anonymity and would probably have undermined confidence in the pledge of anonymity. At the same time, it was recognised that this would inevitably be a limiting factor in subsequent analysis.

Consideration was originally given to producing the questionnaire in Welsh as well as English as a means of encouraging a better level of response from the largely Welsh speaking workforce. This idea was eventually abandoned in the belief that it could introduce different shades of meaning into the questions and could therefore lead to unwanted complications.

It was intended to post the questionnaires from Aston University to the home addresses of all PSB employees, in order to ensure, as far as possible, that the research should be

seen to be independent of PSB. A covering letter was prepared which indicated the purpose of the questionnaire and which stressed the anonymity of the study and its independence from PSB management.

9.3 Validation of the Questionnaire

The draft questionnaire and covering letter were then subjected to validation by using a panel of five staff representatives from different staff groups. This served the purpose of seeking comments on the draft, identifying potential problems in the wording and structure of the questionnaire and also provided an opportunity to reassure and secure the support of an influential group of staff. The documentation was given to the panel and they completed the questionnaire before taking part in a discussion and analysis, which revealed difficulties in understanding certain questions. As a result of the comments received from the panel, the documentation and questionnaire were modified before being issued to all staff as planned.

9.4 The Initial Issue of the Questionnaire

A questionnaire and personally addressed covering letter were posted to the home addresses of all staff in post in March 1995 together with a stamped envelope, for returning the questionnaire, addressed to the researcher at Aston University. The questionnaire was sent to the 198 staff employed at that time and the level of response is indicated in Table 9.1:

Table 9.1: Breakdown of questionnaires sent and returned

Location	Number sent	Number returned	% Response
Dinorwig	129	54	42
Ffestiniog	52	23	44
Bala House	17	9	53
Unspecified in response		2	
Total	198	88 (plus 1 retired)	45

9.5 Analysis of the Results from Initial Issue of Questionnaire

9.5.1 Mean Values of Responses

The questionnaire results were analysed initially by calculating the mean values and the standard deviations in respect of the responses to each question. This was done for PSB

as a whole and also for Bala House, Dinorwig and Ffestiniog individually. The results of this analysis are summarised in Appendix F. The small sample size, particularly in relation to individual sites and the variability, in some cases, of the responses, imposes a severe limitation on the statistical significance of this analysis, as may be seen from some of the standard deviation values. Nevertheless the results were found to be entirely in agreement with what was predicted from direct observation and personal interview.

The responses are ranked in relation to the strength of agreement (where the expectation might have been for an affirmative response) and strength of disagreement (where the expectation might have been for a negative response). The results of the questionnaire bear out many of the views identified during discussion, interview and observation. Although the mean responses to individual questions varied between sites, there was, for the most part, a substantial agreement across PSB.

PSB is seen as being a good provider of equipment (including PPE) and training. Staff believe that they have enough training to do their job safely and enough knowledge and skill to avoid having an accident at work. Management is perceived as genuinely caring about safety and PSB is believed to be understanding, in relation to bereavement or serious illness and to care about the welfare of staff.

At the other extreme, it appears that staff trust in the management of PSB is low and there is relatively weak agreement with the propositions that *PSB policy is effectively communicated to individuals*, that *staff are consulted about changes which affect them* and that *staff are promptly told about changes which affect them*. There is disagreement with the propositions that *relevant staff get the opportunity to contribute to working procedures before they are implemented* and that *contributions from staff are taken into account in final procedures*.

Staff do not believe that work is planned efficiently to avoid wasting time, nor do they believe that supervisors make sufficient checks on work in progress to ensure that it is being done safely or that supervisors undertake periodic inspections of PPE.

There is relatively little evidence for staff being praised for working safely at Dinorwig and Ffestiniog but a relatively strong belief that the workplace is safe as well as moderate support for the view that Dinorwig and Ffestiniog are clean and tidy sites.

Time pressures for completing jobs are generally believed to be reasonable. Safety procedures and the Safety Rules are generally believed to be practicable and applied, although the degree to which staff believe that PPE is used whenever it is required, is relatively weak at Dinorwig. There is a strong belief that accidents are fully investigated although the view that staff are blamed when they make mistakes receives some moderate support. Overall there is a strong belief that PSB does not put production before safety.

At this point in the research, a report was produced at the request of First Hydro, which comprised a summary of the work done, a discussion of the results and initial conclusions and suggestions. The conclusions and suggestions were accepted by First Hydro and therefore could influence both the development of the safety culture of the organisation and any research undertaken after the report had been presented. The discussion, conclusion and suggestions are reproduced verbatim in Appendix C.

9.5.2 Analysis of Variables

A further analysis of the questionnaire responses was then undertaken by analysis of variables (ANOVA) using the SPSS software package. The objective of this study was to identify the extent to which the views of respondents may have been influenced by the sub-group from which they were drawn. Given the nature of the organisation and forming a judgement on the data already collected, the only groupings which might conceivably result in meaningful differences of view were:

- Operational/non-operational site - (i.e. Dinorwig and Ffestiniog/Bala House)
- Ffestiniog/Dinorwig
- Shift staff/day staff - (operational sites only)
- Supervised/supervisors - (operational sites only) - *referred to as "them/us"*

The results were analysed in relation to each of these sub-groups taking a level of significance of $p < 0.05$. The analysis is summarised in the tables in Appendix F.

9.5.2.1 Operational/non-operational sites

Very few questions produced responses with significant differences which could be attributed to the operational/non-operational nature of the site but Bala House staff were more likely to believe *work is planned efficiently to avoid wasting time and the site*

where I work is clean and tidy and less likely to believe *supervisors put production before safety* and *when under pressure, corners are cut on safety*. These differences of view are not surprising given the nature of the sites and the activities of those involved.

9.5.2.2 Shift/Days

Both shift staff and day staff tended to believe *PSB policy is effectively communicated to individuals* with the belief being stronger amongst shift staff. This result is surprising, as it is generally more difficult for managers and day supervisory staff to communicate directly with shift employees. However, shift staff tended to disagree and day staff to agree, that *staff are promptly told about changes which affect them*. This result accords with expectations based on the separate and isolated existence which shift staff often believe they lead. (During the flotation process difficulty was often found in arranging for shift staff to be well represented at briefing meetings.) Staff generally tended to disagree that *staff trust the management in PSB* but shift staff disagreed much more strongly. The logistical difficulties of communication, particularly at a time when the future of the business was so uncertain, would almost certainly lead to a lack of trust and it is reasonable to expect this to be exacerbated with shift staff. Shift and day staff both tended to agree that *the use of Personal Protective Equipment is strictly enforced* but agreement was relatively weak amongst shift staff and strong amongst day staff. Direct observation had confirmed that the enforcement of the use of PPE was not always rigorous. Day staff would contain a significant proportion of non-operational staff and the result can be explained as reflecting a more accurate assessment by those nearest to the problem. There was general disagreement with the statement that *supervisors put production before safety* but it also revealed a difference between shift and day staff which was influenced by location and which is not readily explicable.

9.5.2.3 Dinorwig/Ffestiniog

At Ffestiniog there was weak agreement that *supervisors periodically inspect Personal Protective Equipment* but weak disagreement at Dinorwig. It is possible that this difference may result from the closer relationship of supervisors and staff in the more intimate surroundings of Ffestiniog. There was strong disagreement that *no-one here really cares about minor injuries sustained at work* but the disagreement was very marked at Ffestiniog. This may again reflect the more intimate family type of relationship at Ffestiniog.

9.5.2.3 Them/Us

This distinction revealed the greatest number of significant differences in the responses of staff groups. The groups *them* and *us* were selected from the occupations indicated in Table 9.2 as being broadly representative of *supervised* and *supervisors*:

Table 9.2: Occupations Comprising Them and Us

Them (Occupations)	Us (Occupations)
1 Auxiliary Plant Attendant	3 Engineer (shift)
2 Craftsman/Technician (shift)	7 Administration/Business Support
4 Production Assistant	8 Commercial/Business Strategy
5 Unit Operator/Assistant Unit Operator	10 Engineer (days)
9 Craftsman/Technician (days)	12 Manager
	13 Supervisor

The categorisation indicated above excludes some occupations altogether but provides the best approximation of staff likely to fall into the respective groups of *supervised* and *supervisors*.

In general, supervisors were found to have a more sanguine view of the situation than those they supervised. The supervised were less likely to believe that *contributions from staff are taken into account in final procedures, work is planned efficiently to avoid wasting time* and that *supervisors periodically inspect Personal Protective Equipment*. There was strong agreement that *management care about the welfare of staff* although the agreement was stronger amongst the supervisors. A note of fatalism was indicated by the general agreement that *knocks and bruises are bound to happen at work no matter how careful you are* but those most likely to suffer the knocks and bruises, the supervised, indicated a particularly strong measure of agreement.

There was general disagreement that *at times I do put safety second* and *it is not my responsibility to find solutions to safety related problems* but the disagreement was less marked amongst the supervised. Supervisors disagreed that *when under pressure, corners are cut on safety* although the supervised were neutral. Both groups agreed that *the NGC operational Safety Rules are applied in full* although the supervised agreed more strongly. (It should be noted that the supervisors would include a significant

number of staff who would have no direct involvement in the application of the Safety Rules.)

Location was significant in relation to the responses of *them* and *us* to two questions. Supervisors at Ffestiniog and Dinorwig disagreed strongly that *supervisors turn a blind eye to unsafe behaviour* and the supervised at Dinorwig disagreed even more strongly. However there was a measure of agreement for the proposition at Ffestiniog. Both groups agreed that *the NGC operational Safety Rules are practical and can be applied in all situations* but the supervised agreed more strongly at Dinorwig and the supervisors at Ffestiniog.

9.5.3 Factor Analysis

The questionnaire data was subjected to factor analysis using the SPSS program. Principal components analysis extracted 14 factors (Eigenvalues > 1.0). A negatively decreasing scree plot indicated five factors as most significant. An orthogonally rotated factor matrix indicated the factor loadings, in descending order, on each of the five groups of variables (questions). The five factors identified may be categorised as Indicated in Table 9.3:

Table 9.3: Factors Identified by Factor Analysis

Factor 1 Partnership	Factor 2 Safety Rules	Factor 3 Safety Arrangements	Factor 4 Safety Violations	Factor 5 Safety Supervision
Staff involvement Trust Communication Participation	Application Enforcement Practicability Conformity	Knowledge/skill Training Practicability Equipment provision	Supervisory attitude Safety vs productivity	Instruction Inspections Monitoring Praise

The correlations relating to specific questions and each of the five factors, is indicated in Appendix F – Statistical Tables.

One of the benefits of factor analysis is that by establishing the correlation between certain questions, it is possible to reduce the total number of questions in any subsequent study by framing a question encapsulating each of the individual factors. In

this case, the five factors encompassed a total of 26 of the questions in the individual questionnaire. These factors would therefore be useful in further development of the questionnaire.

In questionnaire studies at Sellafield, Lee, (1993), was able to establish relationships between factors relating to perception of risk and confidence in safety procedures and personal factors such as individual accident experience and length of service. He was then able to use the information to determine the effectiveness of the attitudes in predicting membership of the accident/no accident groups. However, in order to preserve anonymity within a small total population, such personal details were not requested in the studies in PSB. No such relationships could therefore be established. Lee found that attitude to risk was a predictor of accident experience and that contentment with job was also a significant predictor. However, in view of the unique structuring of the factors in each study of this kind, it would be wrong to extrapolate his findings into the PSB study.

Each of the five factors identified in the PSB study is considered in Chapter 12, in relation to the safety culture values of the organisation.

9.6 The Second Issue of the Questionnaire

The questionnaire was issued again in February 1997, adopting the same protocol used on the initial issue (set out in 7.3 above). The questionnaire used on the second occasion was identical except that references to PSB were replaced by First Hydro, to reflect the organisational change that had taken place in the interim. The questionnaire was sent to the 220 staff employed at the time and the level of response is indicated in Table 9.4:

It will be noted that although 220 questionnaires were issued, compared with 198 on first issue, only 69 were returned (31%), compared with 88 on first issue (45%). The substantially lower response rate was disappointing but was almost certainly influenced by the fact that staff were experiencing questionnaire fatigue, having been subjected in 1996, to two other questionnaires at the instigation of First Hydro management.

Table 9.4: Breakdown of questionnaires sent and returned:

Location	Number sent	Number returned	% Response
Dinorwig	163	46	28
Ffestiniog	40	17	42
Bala House	17	5	29
Unspecified in response		1	
Total	220	69	31

Interestingly the response from Ffestiniog held up well (42% cf. 44%) but the response rates had declined significantly at Dinorwig (28% cf. 42%) and Bala House (29% cf. 53%). In the latter case the absolute number of responses was too low to form statistically significant conclusions. (Most significantly, from the point of view of the research, the use of the factor analysis technique becomes unsustainable with a total sample of 69. The use of factor analysis is marginal with the first response of 88. Kline, 1994, suggests a minimum sample of 100 for reliable correlations). A further complicating issue was the relatively large proportion of respondents (8 cf. 5 on first issue), who declined to provide their job group or occupation.

9.6.1 Mean Values of Responses

Adopting the same procedure as before, the returns from the second questionnaire were analysed by calculating mean values and standard deviations in respect of the responses to each question. This was done for FH as a whole and also for Bala House, Ffestiniog and Dinorwig individually. From the analysis of the results of the initial questionnaire, using analysis of variables (ANOVA), it emerged that significant differences in attitudes were found in the different responses of *supervised* and the *supervisors*, (*Them/Us*). For this reason, an additional analysis was made based on *Them/Us*. This analysis was also made retrospectively using the initial results, for purposes of comparison. The results of the analysis are summarised in Appendix F.

The analysis of the results did not reveal any particularly marked or unexpected changes from the initial responses. It was noted that the mean responses to all the seven questions associated with Factor 1 above (*Partnership - staff involvement, trust, communication, participation*), indicated an increased level of agreement in First Hydro overall, although this masks a small downward movement at Ffestiniog and Dinorwig

respectively on two of the propositions, *Staff are promptly told about changes which affect them* and *Contributions from staff are taken into account in final procedures*. What appears to lie behind this movement in attitude, is a marked increase in agreement on all questions associated with Factor 1 by the *supervisors (Us)* occupation group, whereas the level of agreement fell amongst the *supervised (Them)* group on three of the seven questions. On all 7 questions, the *supervisors* group agreed with the propositions implying *Partnership* whereas the *supervised* agreed relatively weakly with 2 of the propositions and tended to disagree with the remaining five. The difference of view between the 2 groups was greatest in relation to, *Staff are promptly told about changes which affect them* and *Contributions from staff are taken into account in final procedures*. The distinction probably reflects the relative distance of the two groups from management decisions. In respect of most of the remaining propositions the views of First Hydro staff, taken as a whole, were very much the same as those of PSB.

A comparison of the views of the *supervisors* and *supervised* between the first and second issue of the questionnaire (1995 and 1997), is much more revealing. The views of the *supervisors* group in 1997 had shifted on almost all the propositions, in a direction which indicated a stronger safety culture. This movement was, in many cases, substantial (in excess of 20% different to the previous mean value). On the other hand, the views of the *supervised* group, whilst exhibiting the same trend on most of the propositions associated with Factor 1, indicated a general move in the opposite direction on most of the remaining propositions. In effect, the passage of two years had resulted in an increased divergence of perception between the *supervisors* and the *supervised*, in respect of most of the propositions in the safety culture questionnaire.

9.7 Further Development and Use of the Questionnaire

Following the publication of a paper, (Booth & O'Loughlin, 1995), in which the methodology and questionnaire were described, at the Electricity Supply Industry Safety Management Conference, another electricity utility applied the questionnaire, with some amendment, to its own situation.

The utility was much larger than PSB and its activities encompassed generation, transmission and distribution of electricity. It employed far more staff and although the

questionnaire was issued to a 25% sample, with a response of some 30%, the number of returns allowed a more rigorous analysis. Although the study is interesting, the differences in approach limited the opportunity for valid comparison. Some of the statements were altered, to refer specifically to safety, whereas the original statement was more general e.g. *staff trust the management in PSB* became *staff trust managers regarding safety* and *staff are consulted about changes which affect them* became *staff are consulted about changes which may affect their safety*. The original statements were designed to reflect research findings which indicated a correlation between management style and safety performance. The alterations indicate that the significance of this was lost on those who amended the questionnaire.

One of the significant findings in PSB was that staff perceptions of management in relation specifically to safety was very positive but much less so in relation to trust and consultation in general. This is likely to bias the results towards a more positive perception for the utility compared with PSB. Nevertheless, a comparison of mean scores, (after corrections to allow for differences in the scales used), indicated that PSB provided generally more positive scores and in some cases, much more positive scores. The comparison was between the generating business of the utility and PSB.

Chapter 10

COLLATION AND PRESENTATION OF SITE DATA

*To observations which ourselves we make,
We grow more partial for th'observer's sake.*

Alexander Pope 1688-1744

10.1 Introduction

Chapters 7 to 9 have described the data collection process and the observations made during the site work. The first distribution of the safety culture questionnaire, in March 1995, marked the end of intensive site observations and it was at this stage that a Report of Preliminary Discussion, Conclusions and Suggestions was prepared and presented to PSB. (Reproduced verbatim as Appendix C). This was as agreed with PSB at the start of the research. (See section 7.2.2). This Chapter represents a collation and presentation of the site data at this stage of the work.

The presentation of the evidence in this Chapter draws upon all the data obtained in the site investigations, including discussions, interviews, observations and the questionnaire responses. The evidence is presented as found with no attempt to be judgmental or analytical. Nevertheless, it is acknowledged that the evidence is inevitably based on subjective impressions and objective data. It must be stated that there was nothing of any significance in the objective data that contradicted the subjective impressions obtained by direct observation. The evidence presented here was the basis of the report to PSB management. A summary of the suggestions for action by PSB management is provided in section 10.10.

As stated in section 7.2.3 and 9.1, all the site data were collected, as far as possible, with the intention of establishing the status of PSB in respect of the factors in the ACSNI prompt-list. The ACSNI Report identifies several issues which are part of an organisation's overall culture and which have a significant bearing on safety culture. These include effectiveness of communication, understanding and sharing of organisational goals, trust, care and concern, effectiveness of consultation and participation, leadership, praise where praise is due, emphasis on competence, good

working conditions and working environment. The structure of the sections in this Chapter is based on the main themes within the ACSNI prompt-list factors.

10.2 A Caring Organisation?

There is a very strong belief amongst PSB staff that management genuinely cares about safety, that PSB is very understanding in times of bereavement and serious illness and that it cares about the welfare of its staff. Several examples of “care and concern” are referred to in section 8.8.5 but it is important to note that in respect of this and other issues, notwithstanding a general majority feeling, individual employees took a contrary view. Some anonymous comments included on questionnaire returns perhaps reveal blind spots in the organisation. One employee at Bala House expressed a strong feeling that PSB could be uncaring and that business needs could come before personal feelings and priorities to the detriment of health, family well-being and commitment and performance at work. It seemed clear that stress levels were high in certain parts of the organisation and no specific action seemed to have been taken to identify and deal with this problem.

As far as safety was concerned, there was a widespread intuitive view that privatisation and commercial forces would lead to safety being sacrificed to production or profit although no evidence in support of this view could be produced by those who made this claim. Staff in general were, if anything, expressing the view that management were more concerned than before about safety targets.

10.3 One Business, One Team?

In fostering teamwork and support for common goals, PSB has an advantage in being a small organisation of less than 200 staff. Against this is the considerable disadvantage that the staff are dispersed between three locations, each separated by significant travelling time. This exacerbated the inevitable tensions that existed within PSB at certain interfaces and contributed to a lack of understanding of the role of colleagues which, in turn, appeared to feed suspicion and resentment. Although it would be wrong to overemphasise this issue, some tensions were noted between and within locations. Considerable efforts were being made to explain the work of Bala House to the other locations but there remained scope for further effort to achieve better integration and understanding. Within Ffestiniog, the historical divisions were being energetically and

effectively addressed by the manager and there was little evidence of the antagonism which apparently once existed.

At Ffestiniog, there was some suspicion and mistrust of Dinorwig and a belief that Ffestiniog was the poor relation. Perceptions held by staff from other locations that Ffestiniog was trapped in the past, seemed to lag behind reality. Whilst Ffestiniog was undoubtedly a conservative unit, attitudes and the organisation seemed to be changing faster than others acknowledged. At both Dinorwig and Ffestiniog, the questionnaire results indicated a lack of faith in the efficient planning of work. Tensions amongst operational staff towards planning had been noted in strong comments at Dinorwig.

Other factors were influencing staff perceptions and attitudes during the study and in some cases were working against trusting relationships with management. These factors included dissatisfaction with certain aspects of the Company Agreement and the annual pay award. Adverse reaction to the pay award was linked to Directors' remuneration which clearly offended staff at all levels who volunteered their strong feelings of outrage. No contrary views were expressed. Another factor was the introduction of STARS, about which there was little enthusiasm and much suspicion. These feelings were common to the assessors and the assessed.

International Hydro was seen as taking resources, including scarce manpower, with nothing to show and the use of contractors was seen as threatening by some staff groups. The extensive use of consultants was also an irritant to certain groups. Most of the staff at Ffestiniog acknowledged that the station was likely to be unmanned in the future but the uncertainty about when this would happen was clearly worrying and provided fertile ground for rumour.

The overriding concern, which grew during the study, was the future of PSB itself, the probability of de-merger and the prospects for PSB after de-merger. This scenario presented more uncertainty than any other issue and was exacerbated by the inability of staff or indeed the management, to influence the outcome. Staff were concerned about jobs, pensions and their share-save options.

The questionnaire indicated that staff in general, did not trust PSB management and the trust was lower at Ffestiniog. In this respect the questionnaire supported the results of the NGC Communication Survey Report (section 6.3.16), which was issued during the study. This indicated a similarly low level of trust in management, although PSB featured much better than most of NGC. It is interesting to note that the low level of trust in management coexisted with the belief that management genuinely cared about safety and that PSB was understanding in relation to care and concern issues.

Considering the matter of shared goals, it was clear that several members of staff had real difficulty in reconciling the aims and objectives of PSB with their own values. This was particularly true of those, such as shift engineers, whose jobs had been changed significantly by the commercial imperatives of privatisation. They retained a strong sense of pride in producing electricity for the nation but could not find the same pride in making money, which they now saw as being the primary objective. Whilst they were operating professionally within the new regime, they retained a belief that the old regime was morally superior.

Insofar as PSB's specific safety goals were concerned, only 41% of respondents to the questionnaire could correctly identify the AFR safety target of PSB and only 22% could specify the correct current performance.

10.4 Effective Communication?

The questionnaire produced low positive scores for the proposition that *PSB policy is effectively communicated to individuals* and a particularly low positive score for the proposition that *staff are promptly told about changes which affect them*. These results were similar to the PSB results in the NGC Communications Survey. Many serious attempts at communication were observed during the study via the PSB Newsletter, the Local Council and HESACs and interactive video presentations installed at each location as well as many specific staff briefings. Nevertheless, several examples of ill-founded rumour were also noted. The residual impression was that management were trying to communicate as fully and as openly as possible but that on issues such as de-merger, the staff always believed that they were not being told everything. It would seem almost certain that this fact coloured staff views on the effectiveness and timing of communication and on the low level of trust in management.

10.5 Consultation and Participation?

The questionnaire produced a low positive score for the proposition that *staff are consulted about changes which affect them* and negative scores for *relevant staff get the opportunity to contribute to working procedures before they are implemented* and *contributions from staff are taken into account in final procedures*. At the same time, the Local Council and the HESAC meetings were dealing in detail, with matters of substance and the questionnaire revealed that staff felt they were well informed about the activities of their safety committee. There was a tangible atmosphere of antagonism towards management within Local Council meetings which was completely absent in the HESACs. It is possible that the Local Council atmosphere is a function of its negotiating role but the feeling of antagonism towards PSB management was not encountered during any interview or discussion with individual members of staff.

The HESACs were conveniently used for executive decision making by the managers who chaired them and they seemed to operate pro-actively, effectively and without tension. Instances were noted where the Local Council was used as a *Court of Appeal* for inappropriate and trivial items, such as expenses payments, which were the responsibility of the location managers. This undermined location managers' authority and was resented by them.

An example of genuine participation and involvement was the creation of a focused, multi-disciplined team for the MIV bearing replacement project. Staff safety representatives were observed to be playing a positive and valuable role and were both supportive of management's safety objectives and occasionally promoted initiatives themselves.

10.6 Leadership, Management and Supervision

The PSB style of management observed during the study was open, tolerant and certainly not autocratic. Several examples were noted of considerable efforts to communicate the maximum amount of information to staff, consistent with commercial confidentiality and particularly the confidentiality arrangements surrounding the issue of de-merger. It is significant that the questionnaire provided strong support for the view that staff and management could talk honestly and openly about safety problems.

Observation confirmed that management were taking a pro-active stance on safety, and the HESACs provided a good example of taking the moral high ground. This was the declared aim of the General Manager. The questionnaire confirmed a very strong belief that management were genuinely concerned about safety and observation supported the view that this concern was sincere. The General Manager was certainly believed to be concerned about safety, particularly about good housekeeping. The direct interest of the General Manager was exploited at Ffestiniog in the sense that direct approaches were made to him which tended to subvert line management authority. Such approaches were found to be effective and therefore understandable but were resented by line management and supervisors.

The General Manager's profile and visibility was considered by many staff to be too low, particularly at Dinorwig and he was regarded by a significant number of staff as distant and aloof. This was in conflict with his stated intentions and may perhaps, to some extent, be due to an inwardly focused stance by top management during the establishment of PSB and a more outwardly focused stance as the business approaches de-merger. Some senior staff, who needed contact time with the General Manager, found this difficult to achieve due to the demands of his schedule and the time he spent away from PSB locations. The senior management team seemed to be united and co-ordinated and working with no evident internal tensions.

The questionnaire results on supervisory issues indicated relatively weak support for the proposition that *supervisors always ensure that staff understand their instructions* and disagreement with the propositions that *supervisors make sufficient checks on the work in progress to ensure it is being done properly* and *supervisors periodically inspect PPE*. Against these apparent indications of weak supervisory safety control, the proposition that *supervisors put production before safety* was strongly refuted. There was relatively poor support for the proposition that *staff are praised for working safely*. The difficulties of exercising effective supervision and discipline against the background of the relationships which develop in small and stable *family* communities, such as Ffestiniog, were highlighted during the study.

The sincerity of the PSB management commitment to safety has already been noted but a number of indicators, some discussed more fully below, suggest that this commitment is limited in its effectiveness. These indicators include, the accident rate itself, which was certainly running at a significantly higher rate than other CEEGB successor GENCOs, the standard of housekeeping, which was good in some areas but ranged from poor to extremely poor in many areas, the fact that the ISRS system was not meaningfully implemented and the fact that knowledge of risk assessment was very weak, at least during the early part of the study.

10.7 Working Conditions and Environment

The poor and uneven standard of housekeeping is referred to several times in Chapter 7 and the fact that housekeeping in areas in the public eye were generally good is also noted. Staff believed strongly that their workplace was safe and there was moderate support for the view that their site was clean and tidy. This perhaps is an indication that the staff take the ambient conditions as the acceptable norm. The poor housekeeping seemed to result from items not removed at the end of a job as well as many cases of items being deliberately placed somewhere inappropriate. Either case reveals poor attitudes and the acceptance of low standards. A safety walk which was observed during the study was not carried out against any effective pre-determined standards, providing evidence that the monitoring procedure was ineffective in combating poor housekeeping standards. Staff referred to time pressures as an explanation of poor housekeeping and supervisors referred to resource limitations as an explanation. Neither explanation was in any way convincing. The impression gained and also the view volunteered by staff, was that time pressures and staffing levels, particularly at Ffestiniog, were not over-demanding. The questionnaire also supported the view that time pressures were reasonable. Exhortation as a means of improving the situation was certainly futile as were periodic purges which tackled the symptoms not the disease.

It is clear that PSB was regarded by staff as a good provider of material resources and of PPE in particular. It was also clear from observation that PPE was not always used where it was mandatory and that the use of PPE was not effectively enforced. The view of PSB from the public perspective was sampled during the study and was generally impressive. It was noted that the non-use of PPE could be observed by the public at both sites. The condition of the buses and the standard of the public exhibition at Ffestiniog

was markedly poorer than at Dinorwig and this was a major influence on the morale of the staff at Ffestiniog involved in public visits.

10.8 Risk Awareness and Risk Perception

The ACSNI prompt-list identifies many factors as good indicators of a strong safety culture, which in various ways, relate to the integration of a risk assessment approach within the organisation and within the staff. As well as forming the basis of the modern approach to the management of safety, consideration of risk exposure is also the basis of the ISRS approach. Much guidance had been issued by NGC Health and Safety Branch on the subject of risk assessment early in 1993, in response to new safety legislation but by mid 1994 this was largely unknown to the bulk of PSB staff, including most of the senior staff. Questioning during interviews and discussions, dealt with risk assessment and this was a factor in prompting an increase in awareness of the topic. For this and no doubt other reasons, there was a much greater awareness of risk assessment by the end of the study, although no direct evidence was obtained of the extent to which risk assessment considerations influenced the attitudes or behaviour of staff and supervisors in the performance of their work.

10.9 Safety Management Procedures

It must first be stated that PSB has a good inheritance of safety management procedures and has the resources and technical skill and knowledge to develop or modify existing procedures and to introduce new procedures. Certain inaccuracies were however noted in the PSB Safety Policy Statement. New Safety Rules were introduced towards the end of the study but a number of people believed the Safety Rules were transmission oriented and the requirements of the Safety Rules were regularly ignored in respect of certain types of work. Internal safety audit procedures were not universally well developed.

It has been noted in Chapter 7 that ISRS was effectively not implemented in PSB although model ISRS standards are available and would have greatly assisted the implementation process. Few people in management and supervisory positions had any knowledge or involvement in the system.

The questionnaire indicated a high positive response for *in all circumstances I understand exactly what to do in an emergency evacuation*. On the face of it this is encouraging but it was noted that the individual responses varied widely which is a matter of concern given the nature of the sites. There was therefore scope for improving individual understanding of emergency evacuation procedures further. The exercise conducted with the Fire Service during the study revealed many learning points and above all, a need for more exercises, as the performance of the Fire Service on this occasion left much to be desired and was quite unsatisfactory given the nature of the hazard.

10.10 Main Observations Reported to PSB Management

The results described above, confirm that PSB had many factors operating in its favour in relation to its safety culture. PSB has an extremely strong inheritance of well designed physical assets, in good condition, high quality procedures and systems, good human relations and an excellent base of technical knowledge and experience in its well qualified and motivated staff and management. It is also financially healthy.

The preceding observations and discussion nevertheless indicate that there is considerable scope for further strengthening the safety culture of PSB.

It is assumed that PSB is committed to aspire to the standards of the very best world performers on management indices relating to profitability, productivity, availability, efficiency etc. If the stated NGC commitment is to be believed, safety performance ranks equally in importance to these other criteria and therefore PSB should aim to be equal to the best in the world on safety performance too. Individual incidents, although infrequent, reveal PSB's vulnerability and exposure to inadequate safety performance, especially to the effect of human error in an environment dominated by procedural controls. Significant accidents are rare in such a small workforce and therefore underlying unsatisfactory attitudes and behaviour may be difficult to detect until an incident highlights some worrying but hitherto latent problem.

At the start of site observations, most staff had a very low level of knowledge of risk assessment although a risk assessment approach has been implicit in the Health and Safety at Work Act for many years, recent legislation is framed around risk assessment requirements and risk assessment is the basis of the modern approach to the

management of safety. It is worth noting that research has indicated that the level of risk tends to be underestimated by those who work with the risks. It was also noted that consideration of risk exposure is the basis of ISRS although the system was not effectively implemented and staff had little knowledge of it. ISRS is merely a management system providing a systematic approach to safety management but as with any other management system, it requires the commitment of the organisation if it is to be effective. It is suggested that ISRS does provide an approach completely complementary to the need to enhance risk perception and awareness and to the establishing of better standards in certain areas. A decision should be made, either to implement ISRS wholeheartedly or to abandon it. The present adoption without implementation, is unacceptable.

The issue of poor housekeeping is linked to risk awareness and risk perception. For example, it is unlikely that someone leaving combustible waste in a cable flat consciously considers that it may add to a fire hazard or that someone leaving a switch-room cluttered or partially obstructing an emergency exit, considers the problems a congested floor could create if the room were to be filled with smoke or that those who tolerate an untidy workshop consider the additional hazards this introduces. Altogether, poor housekeeping creates a background of low standards and encourages further untidiness and a poor standard of self discipline. The questionnaire results suggest that respondents have positive attitudes to safety and they believe that management is genuinely interested in safety. They also believe quite strongly that their sites are clean and tidy. This perhaps suggests that there is support for safety but that staff attitudes are trapped within existing standards. This suggests that there is a need for a project to move standards and behaviour with the ultimate objective of encouraging the development of better attitudes as a basis for improving safety culture. Such a project would need to move risk perception and awareness.

There is no simple solution to this behavioural problem, which is a product of poor standards and attitude. The only practical approach would seem to be a co-ordinated and sustained drive as part of an overall strategy which effectively harnesses the efforts of the staff themselves. An attack on this problem is central to an improvement in safety culture and the management of safety and risk generally. It warrants a major project with budgeted resources, driven by a project team harnessing the participative efforts of

different staff groups. The strategy must embrace on-going and continuing follow up to maintain behavioural standards at a sustained new level.

The evidence suggests that management are strongly committed to safety and this is the general view of the staff. The explanation of the apparent paradox of sincere management commitment coexisting with the situations revealed by the indicators referred to above, is probably a combination of an acceptance of standards which are believed to be tolerable and an inability to identify what further measures can be taken to effect an improvement. It is not a matter of whether commitment is sincere, or even visible, which it clearly is, but of how far the commitment goes. It is acknowledged that there are many priorities competing for management attention and that safety management will receive a level of attention commensurate with the perceived mismatch between actual and acceptable standards of performance. The rest of the line management, supervisors and staff will react proportionately to the perceived level of management concern and demands.

Although specific actions could be taken, directed at each of the matters highlighted, it is suggested that a piecemeal approach would be inappropriate and the real need is for the implementation of a carefully considered strategy, embracing all relevant issues. This should be developed in a participative way between management and staff to maximise involvement and commitment. The plan developed should be systematic, with priorities and time-scales identified, resource implications worked out and resources budgeted. It is important that a safety culture initiative should be integrated with other management efforts in PSB and not be seen as something separate. For example, there would be much in common with any management initiative to improve quality.

The intention of the safety culture strategy is to improve risk awareness and perception and to influence attitudes and behaviour towards the acceptance and expectation of higher standards. The strategy should therefore include practical safety and risk awareness workshops for staff. These should cover the cost of losses, human behaviour aspects, safety culture issues and supervisory implications. Such workshops should be participative and draw upon the experience of the staff and require their active involvement. It is also important to harness the active involvement and support of the staff not only in developing the strategy but in its implementation. It is therefore

appropriate to establish teams within PSB to co-ordinate and provide direction for implementing the strategy within their work areas and work groups.

It is suggested that moving attitudes can best be achieved only if staff see a determined sustained and co-ordinated approach. Piecemeal efforts are likely to meet with scepticism and to end in failure. It is likely that most staff expect such initiatives to be short lived and to peter out. It is therefore vital that the strategy is carefully planned and based on a strong foundation of commitment binding on management and staff groups.

The most important single factor in the success or failure of the strategy will be the commitment and focus of senior management. As de-merger approaches it is unrealistic to expect the necessary level of single-minded commitment by either staff or senior management. It is therefore suggested that a safety culture initiative should be undertaken after de-merger when it could serve as a means of binding the organisation and building pride in the independent company.

10.11 The Way Forward as Suggested to PSB Management

The following staged approach is suggested: (no detail is given since it is important that this arises from the collective consideration and involvement of the staff and management of PSB)

- Discuss Report with staff in consultative forum
- Agree broad approach in principle
- Set up a balanced and representative team to consider implications and to develop strategy
- Identify priorities, times-scales and resources
- Establish safety and risk awareness workshops
- Establish implementation teams with terms of reference, responsibilities and budgets
- Periodic review of progress
- Amend or adjust programme

10.12 Analysis of Data

The data from the historical review phase of the research, the evidence presented in this Chapter, the data derived from the second distribution of the safety culture

questionnaire and the events impacting on PSB in the intervening period (see Chapter 11), are analysed in Chapter 12, Discussion and Conclusions. Comments on the PSB response to the interim report are provided in section 11.4.12.

Chapter 11

**EVENTS IN FIRST HYDRO FROM MARCH 1995 TO FEBRUARY
1997**

Nothing is permanent but change.

Heraclitus c500 BC

11.1 Introduction

As this research seeks to track, analyse and explain the safety culture of the organisation during organisational change, it is clearly important to note the events and changes affecting First Hydro between the issue of the first questionnaire in 1995, which coincided with the completion of data collection, recorded in chapters 6, 7 and 8 and the issue of the second questionnaire in 1997. The purpose of this Chapter is to record events in First Hydro between March 1995, when the first questionnaire was issued and February 1997, when the second questionnaire was issued.

The information recorded in this Chapter was obtained by informal discussions and structured interviews with managers and staff at all sites and by direct observation, during a number of visits in the intervening period. Although the time spent on site was much less than during the initial data gathering exercise, it was judged to have been sufficient to obtain a reasonably complete picture.

11.2 Major Organisational Change

The long period of doubt and uncertainty surrounding the future of the pumped storage business came to an end in 1995. PSB was formally de-merged from NGC on 17 November 1995 and was thereafter known as First Hydro. The board of First Hydro was formed on the same date and comprised the existing General manager as the Managing Director with the existing Commercial, Plant and Engineering Managers appointed as Directors of their respective functions. The senior management team was therefore unchanged. First Hydro, at this stage, was still owned by the RECs via PSB Holding Company. The intention was to sell First Hydro by means of a trade sale.

In the first round of bids three companies had been successful:

- Dominion - a US utility company.
- Mission Energy - a US utility company.
- Scottish Hydro.

These companies, whose names were announced on 17 November 1995, were now invited to prepare final bids. (It may be noted that considerable effort was made to put together a management buy-out but this was prevented by a Government Minister, following intervention from within the industry.) The preparation for the final bids triggered a period of intense scrutiny of all aspects of First Hydro's business by teams representing the three bidders. This made extremely heavy demands on First Hydro resources and specifically on the time of senior management.

The successful bidder in the final round was Mission Energy, who became owners of First Hydro on 22 December 1995, on completion of the sale. Mission Energy were the bidder most favoured by the senior management of First Hydro and were believed to have been most thorough and professional in their preparations. (It may be noted that Scottish Hydro had indicated that they would retain the existing senior staff for six months!). A take-over by Scottish Hydro was least favoured by staff. It was generally believed that this would lead to the stations being run as profit centres from Scotland, with consequent large reductions in staff numbers and outsourcing of much technical expertise. A concern, which was widely expressed, was that the successful bidder, Mission Energy, had paid a much higher price than the City had expected and that this would result in the setting of very demanding financial targets. Mission Energy Company is one of the leading developers, owners and operators of independent power facilities in the US. It is based in Irvine, California and at the time of the acquisition of First Hydro, owned approximately 2000MW in 34 operating plants throughout the world. The parent company of Mission Energy is Southern California Edison Corporation.

Mission Energy determined that First Hydro would continue to operate as a stand-alone company and the existing senior management team were all retained as board directors with the managing director continuing in that role. Five new directors were appointed from Mission including the Chairman of the First Hydro Board.

A condition of the sale agreement was that First Hydro would purchase and operate the Museum of Wales building adjacent to Dinorwig. An early indication of the relationship with Mission was provided when the managing director faxed California for approval to proceed with the purchase of the Museum of Wales for £400k (his previous level of delegated financial authority with NGC had been £100k). The return fax simply said, "*I trust your judgement!*"

The early view of First Hydro senior management was that Mission were an entrepreneurial and non risk-averse organisation and that the relationship would be professional and with demanding targets but that there would be little day to day interference.

11.3 Immediate Effects of Change of Ownership on Staff

Discussions with staff revealed a widespread relief at the outcome of the ownership question. Their worst fears of job losses had proved unfounded, their terms and conditions of employment were unaltered and a new section of the Electricity Supply Pension Scheme was being formed for existing staff, who would retain the same pension benefits, whilst existing PSB pensioners became pensioners of NGC. The NGC staff share-save scheme was also retained in a modified form for First Hydro staff and was actually grossed up by First Hydro for standard rate taxpayers, to ensure that they were no worse off because of Inland Revenue rules. The severance terms which had been available in NGC were also guaranteed until 1999. The Directors of First Hydro had faced considerable opposition from the RECs, during the sale negotiations, in their attempts to secure these conditions for staff, something which they believed would be crucial to the successful launch of the new company.

Apart from the ongoing process of change within First Hydro (recorded below), the purchase of the company by Mission appeared to have had no significant effect on the bulk of the staff. This is perhaps significant in itself, in that the effects on staff would probably have been dramatic if the Mission bid had failed.

11.4 Events March 1995 to February 1997

11.4.1 General

Following the collation and analysis of data from the first questionnaire, a report was prepared by the researcher for First Hydro management detailing initial conclusions and

suggestions. This was at the request of First Hydro. The verbatim report, as finally presented, is reproduced in Appendix C. The report was discussed first in draft with the manager of Ffestiniog who had been charged with dealing with the report and progressing the recommendations. With slight amendments the report was accepted by the First Hydro executive and it must therefore be noted that to the extent that the suggestions were adopted, the researcher would have a further influence upon subsequent events. (See subsequent comments in 11.4.12).

A senior team from Mission visited First Hydro in January 1996. Discussions with management and several staff indicated that they had made a favourable impression. First Hydro continued to operate very profitably, e.g. Ffestiniog was called upon for more generation in 1995 than in the whole of the two previous years.

11.4.2 Staff Issues

11.4.2.1 De-manning of Ffestiniog

The main factor driving staff related issues relating to staff at Ffestiniog, was the strategic requirement to automate the station so that it could be operated from Dinorwig and produce significant cost savings. The manager had produced a plan, which had been approved by the Directors, to reduce staff levels at this stage from 46 to 28, with no compulsory redundancy. The scheme had been put to the Local Council (now renamed the Company Council) and then to staff, in December 1995. Some staff would take voluntary severance, some would be re-deployed to Dinorwig and some would be retrained for employment at Ffestiniog. All staff were counselled individually to determine their wishes and then management were to see if they could accommodate those wishes. It was intended that those who were staying should have meaningful jobs in which they could be employed flexibly in operations and maintenance work. A detailed training programme had been developed and implemented, to enhance craft skills, with the objective of reaching NVQ level 2. The training comprised one day on general safety, one day on the Safety Rules then several days of theoretical and practical training by an external lecturer and by the Ffestiniog foremen respectively.

Following consultation, this initial downsizing plan was implemented successfully. After the counselling of individual staff, formal offers of severance terms were issued in May 1997, to those who had elected for this option. The date of departure of some staff

was adjusted to allow them to complete a share-save plan and avoid the tax penalties due to early completion. Some Dinorwig staff were given severance terms thereby facilitating the re-deployment of Ffestiniog staff to Dinorwig. In some cases this provided promotion opportunities for staff from Ffestiniog. Shift teams at Ffestiniog no longer included an engineer and now comprised two multi-disciplined (as a result of the re-training) craft operators. Professional engineering back-up was available from Dinorwig.

11.4.2.2 Investors in People

By September 1996 First Hydro was considering seeking an Investors in People award. Following an initial assessment, it was agreed by the executive and the Company Council, to pursue the award and the Ffestiniog manager was leading a steering group of management and staff to prepare the ground. An external consultant was helping with pre-assessment towards the end of 1997 with the intention of obtaining a formal assessment in May 1998. The key areas for assessment would be:

- Business awareness
- Training and development plan
- Managers training (foremen upwards)
- Communications

11.4.2.3 STARS

An important feature in achieving the Investors in People award would be the STARS scheme, which had proved to be unpopular with all levels of staff when it was first introduced. This unpopularity was confirmed by a communications survey commissioned by First Hydro in 1996 in which STARS received a very negative rating although there was some *support for the concept but not the system*. A general criticism amongst managers and supervisors was that STARS scoring did *not reflect commitment, loyalty and hard work*. A working group of management and staff was established to review STARS *so that it was more slanted towards personal development*. The questions were to be more positive so that performance reviews were easier to carry out and the scheme was to reflect staff attitudes to safety and security and working with others. The scheme was modified and simplified to reduce the numbers of key competencies, to link development and training and to reflect the commitment factor.

STARS reviewers held moderators meetings to achieve consistent grading and the results were fed into the Business Plan and the training budget. The scheme was now referred to not as STARS but as the Personal Appraisal Scheme.

11.4.2.4 Profit Related Pay

The continuing profitability of First Hydro meant that profit related pay continued to feature significantly in staff remuneration and in both 1996 and 1997 amounted to 9% bonus in addition to salary. A further bonus pool resulted in payments of up to £500/person and was based on performance factors which included safety. The net result was that the financial reward for good safety performance was totally swamped by payments related to profit. It was not linked to individual performance. This fact was acknowledged by management and could be considered to provide a rather different message to the Safety Policy Statement in which *"safety performance ranks equally with the other primary objectives of the Company."*

11.4.2.5 Communications

A communications survey was undertaken by First Hydro in May 1996 (First Hydro, 1996), which was essentially a repeat of the survey done by NGC in 1994 (Lowe & Carrington, 1994), which had included PSB. The NGC survey (see Section 6.3.16), had revealed a very poor state of affairs in NGC generally (less so in PSB), in which the staff saw the Company as fragmented with conflicting interests, the majority of staff were confused, resentful and demoralised about restructuring; intimidated by downsizing and its implementation, believed that management were remote, were demotivated and overloaded and where communication was only downwards and was mistrusted. The new survey, asked much the same questions as the first survey with most of the questions requiring responses based on an eight point Likert scale. The results were very much more positive than the earlier NGC survey although most of the responses were only marginally positive. The most negative response was reserved for the STARS scheme and staff felt much more positively towards their immediate managers and their Departments, than they did towards senior managers, Directors and the Company generally. Very positive responses were received in relation to satisfaction with FHC as an employer and in relation to optimism about the future of FHC. It must be noted that there was very strong support for the proposition that *adequate attention*

and priority is given to safety aspects and concerns, FHC is effective in promoting safety awareness and If you have a safety concern, do you know who to report it to?

11.4.2.6 Other Training

Other significant training efforts included refresher training in the Safety Rules which had been amended by NGC, prior to de-merger. In April 1996, ISRS training was given by DNV into hazard identification and incident investigation. A one-day risk assessment seminar was given at Dinorwig in March 1996 by Professor RT Booth, which was attended by the Engineering Director and senior staff from both power stations.

It is interesting to note the reactions of different staff groups to the training programme which was implemented to provide multi-skilling at Ffestiniog. References were made by those undergoing the training, to *"Space Cadet training,"* whilst those who had previously undertaken traditional craft training referred to *"Kwik Fit Fitter training!"*

11.4.3 ISRS

The Managing Director had said that ISRS must be implemented and ISRS targets were included in the Business Plan. The target for Ffestiniog was to achieve a consolidated level 5 score (version 6) by the end of 1995/96. (They had achieved level 5 (version 5) in their earlier baseline audit and a *mock audit* undertaken by NGC Safety Branch in December 1995 *"had resulted in a scraped level 5."*) An external audit was undertaken in April 1996 which resulted in achieving level 5. ISRS was being reborn at Ffestiniog, driven by the location manager. He had written to all staff at Ffestiniog explaining ISRS and loss control and had appointed element champions. An annual review was to take place in January each year involving element champions, shift engineers and foremen. Actions would be set at this review. Planned inspections were now taking place and check lists were available. The manager was *"not interested in chasing marks for the sake of it but interested in getting the best out of the system consistent with reasonable effort...to aim for a sensible level and sustain it."*

As a result of the ISRS initiative an accident investigation procedure had been introduced which had not existed before, the COSHH inventory was now up to date and a new impetus had been given to producing risk assessments. There was a perception

that the Plant Director was not convinced of the need for ISRS (a perception shared by the researcher) although he in turn claimed that the Managing Director was insufficiently personally involved.

11.4.4 Risk Assessment

Until 1996, very little had been done in First Hydro in respect of general risk assessments. Serious assessments of risk had been made in relation to a few major projects such as the MIV bearing changes but risk assessments for more routine activities lagged far behind. A First Hydro procedure for conducting risk assessments was issued in March 1996, based on the NGC policy document GS-MP9, which had been issued in 1993. Although a local policy was now in place and there was a general appreciation of the need for risk assessments, the procedure was “*not yet off the ground*” according to a shift engineer.

By July 1996 the manager at Ffestiniog was setting targets for risk assessments but acknowledged that although progress was being made they were “*far behind with the legal requirements.*” Seminars were planned on risk assessment to assist supervisors to perform risk assessments. Further progress was made with the appointment of the First Hydro Company Safety Advisor, who had produced a computer based pro-forma to assist staff in producing risk assessments.

11.4.5 Appointment of Safety Advisor

The de-merger from NGC and consequent loss of NGC Safety Branch advice, caused the First Hydro management to decide to appoint an in-house safety advisor. (This appointment was made in June 1996.) The Plant Director had taken the primary role in promoting safety at Dinorwig and the manager at Ffestiniog had done so at that site. They were both aware that this was making great demands on their time and with de-merger as well as the assumption of wider responsibilities of company director, the conflict between their various duties was increasing. Both therefore welcomed the appointment.

By May 1997 a number of staff indicated that the Safety Advisor was having an impact and “*getting some peoples' backs up.*” He had intervened to stop some bad practices and was giving one hour presentations to staff on risk assessment. He was also

intending to introduce a suite of IOSH courses on Working Safely, Safety for Senior Executives and Safety Awareness. He was himself now involved at the planning stage of major jobs and as noted in 11.4.4 above, had developed a computer based aid to risk assessment.

11.4.6 Specific Safety Issues

In order to relate the factors identified as safety culture indicators with safety performance, it is necessary to note the actual situation in respect of safety related issues, accidents and dangerous occurrences. Ongoing safety actions that took place between March 1995 and February 1997 included the following:

At Ffestiniog:

- BA sets were removed after agreement with the Fire Brigade. The Fire Service had agreed that they would enter any part of the station, without guides, thus removing any further need for BA training for Ffestiniog staff.
- Following an insurance report, an additional emergency stairway had been constructed.
- An electromagnetic field survey at the rear of the 16kV cables in the switch-room had resulted in the provision of guards to prevent access to avoid exceeding NRPB exposure levels with the generators at full load.
- Asbestos tiles in the control room had been removed.
- A crash barrier had been erected near the Visitor Centre following a vehicle accident in icy weather.
- A lighting contract had been completed which was commissioned after a lighting survey.

At Dinorwig:

- The control of smoking underground was being increased with particular reference to contractors.
- Noise surveys and frequency spectrum studies were being used to reduce noise exposure with particular reference to the maintenance of the alternator acoustic enclosures and the selection of more suitable ear defenders.
- The anti-collision gear on the turbine house cranes was found not to be working and this was being investigated.

11.4.7 Incidents

Incidents that took place between March 1995 and February 1997 included the following:

At Dinorwig:

- An electrician, working on lighting in the bus-bar galleries, fell whilst climbing over a voltage transformer, breaking ribs and a collar bone.
- An employee had suffered a strained shoulder carrying scaffold boards.
- An explosion had occurred when 18kV was inadvertently applied to the 3.3kV thyristors during synchronising (there were no injuries). This had occurred when a relay had been reset in the control room, an operation which had been performed on many previous occasions. Investigation indicated a weakness in the design of the control circuits, which should have inhibited the operation. It was found that a design modification had been suggested in 1979 but had not been implemented. Here was a latent failure which had lain dormant since the station was commissioned.
- Management gave permission to a member of staff to hold a fund raising event in the Museum of Wales for a local child who suffered from brittle bone disease. During the event a clown/juggler placed a short ladder against a free-standing screen. A child climbed the ladder, which unfortunately caused the screen to fall on top of the child with brittle bones who then received severe broken bones.

At Ffestiniog:

- An employee who had a twisted spine tripped over a hose on the pump floor and fell breaking his arm. His back was further injured during hospital treatment and he subsequently retired on ill health grounds.
- A length of conduit fell from an overhead crane after refurbishment. There were no injuries.
- A lubricating oil hose failed, resulting in bearing failure on one of the generators and the loss of some 50 gallons of oil into the sump. Fortunately a new interceptor pit had recently been commissioned in anticipation of just such an event and no environmental damage was done.

It should be noted that by July 1997, the rolling annual average accident frequency rate in First Hydro had been reduced to zero.

11.4.8 Site Observations

The following points relating to housekeeping were noted during site visits which took place between March 1995 and February 1997:

At Dinorwig:

The machinery workshop was a good working environment but swarf was noted around the drill indicating that the fitters who use the room do not clear up. The electrical workshop was untidy, although better than when seen on previous occasions. A foam tank was obstructed by metal and in the event of a fire it would not have been possible to attach a hose (itself obstructed by plastic containers) to the tank. The instrument workshop had been refurbished with a new ceiling and lighting and was tidy. Work was in progress to improve the corridors and to provide a cleaners' store. The lecture room was very untidy and dirty and was clearly not often used.

The switch-rooms, which had previously been used to dump all manner of items, were much tidier and generally clear of rubbish. There was evidence of slip resistant surfaces being laid and the machine hall floor was being carefully covered as protection during a forthcoming outage. Steps to the MIV gallery had been made less steep and the area was now covered by video cameras, operated from the control room, to enable the control engineers to observe any incident whilst work was in progress on the MIV bearings. Gaps in the railings where public access was permitted had been filled with mesh as an additional precaution to prevent children falling through. Ladders and ropes were observed quite close to a shaft rotating on spinning reserve. The turbine hall ceiling had now been completed. This was a major project and was designed to direct water seepage through the rock more effectively into the drains and thereby avoid damage to the turbine hall floor.

Altogether the impression received was that housekeeping standards were generally considerably improved although they were by no means universally good. Much work had been done to improve the environment as a result of a substantial investment programme.

At Ffestiniog:

The site at Ffestiniog was visited soon after the visit by Mission in January 1996. Generally the site was clean and tidy.

A new and better VDU display had been fitted in the turbine hall for communicating information to staff (including information on the previous day's profit) but a scaffold cradle had been placed in front of it. The turbine hall floor had been diamond polished and looked good. Work was taking place to install cables for automating the sets and very long cable runs had obviously been installed with care. New touch screen controls for Unit 1 had been installed in the control room. Similar controls were to be installed for the other Units. (Mirror controls were being installed at Dinorwig so that the Ffestiniog plant could be operated from there.) The work included control cabling under the control room and fire segregation was being arranged. It was noted that fire segregation had been provided around a fan and heater and for the fire pumps. The stores had been equipped with a new floor surface and new racking and was neat and tidy. The storekeeper had been personally involved in the new arrangements. The mechanical workshop was tidy with walkways clear and the electrical workshop was tidier than previously although an unguarded drill was noted and the gap between abrasive wheel and rest was too large. A decision had been made to provide Ffestiniog with a covered outdoor store to replace the existing compound which was resented by Ffestiniog staff. New First Hydro logos and overalls were much in evidence.

On a slightly later visit the outdoor area was inspected and both the gates of the outdoor compound were left open and the items inside were found to be stored very untidily, particularly the cable drums. One door was hanging off a store, the LPG store was open and oxygen and acetylene cylinders were adjacent to each other. The scaffold store was open and louvres were missing to the earth store such that a child could gain access. The oil store was unlocked. The fact that doors were unlocked during the working day may be excusable but the impression gained was that they would almost certainly not be locked at other times. It was further noted on a later visit in May 1997, that the screen based communication system to staff in the turbine hall, was not at all user friendly in spite of the obvious care and attention devoted to developing the presentation. The screen was placed at an inconvenient height and the mouse was difficult to operate. The office formally used by Ffestiniog managers had been refurbished in the style of some of the remaining CEGB furniture, using local craftsmen and would now be suitable for use as a boardroom.

The impression received was that risk exposures were being properly identified and much thoughtful and practical investment was taking place into improving the environment at Ffestiniog. It seemed, at both sites, that management intentions for achieving improvements were being pursued sincerely but that the actions of many staff effectively undermined attempts to move the situation forward. Their attitudes were still trapped in a culture which lagged behind the physical changes which were being made.

11.4.9 Technical Changes

The remote operation of Ffestiniog from Dinorwig was scheduled to be live from the end of 1997 and was progressing on target. The control person for Ffestiniog would then be the Dinorwig control person, some of whom were spending time at Ffestiniog to familiarise themselves with the plant.

Technical performance of the plants had improved in terms of MW/man hour, income/man hour, utilization/man hour. Staffing levels were also lower. The plant was more responsive to market needs. E.g. The new governors fitted to the machines at Ffestiniog had improved the primary and secondary response times of the machines, (positive power within 10 seconds sustained for 30 seconds and positive power within 30 seconds sustained for 15 minutes, respectively). The Ffestiniog machines could now pick up from 55MW part loading to 90MW full load in 10 seconds. These performance improvements were vital in relation to the new contractual regime.

An interesting feature of purchase of the Company by Mission was that the deal had been financed to a significant degree by the sale of 25 year bonds paying 9%. This meant that the Company was committed to providing a sufficient income stream to meet this requirement for 25 years. The original design life of the plant was 40 years and the civil works 80 years and Ffestiniog was already 33 years old. This had meant that a commitment had to be made to extending the life of the stations. A major review had been undertaken of the entire infrastructure and it had been concluded that an annual spend of c£1M would be required every year at Ffestiniog alone, to maintain the plant in operating condition.

By May 1997 a total of four MIV bearing changes had taken place, using the technique referred to in section 8.4.7 and described in detail in Appendix A. In a further

development of the technique, it had been demonstrated that a turbine bottom cover could also be replaced whilst the station was operating. (i.e. with the shaft flooded). This was regarded by the station management at Dinorwig to have been a task at least as challenging as the MIV bearing changes.

The pen-stock leak at Dinorwig, referred to in section 7.7.4, had been becoming increasingly severe and was plugged in May 1996 using a high pressure grouting technique. This represented a good example of the approach of First Hydro management to a major technical issue with severe associated risks. A detailed technical account of the process and the approach is given in Appendix B and is not repeated here but the significance of the project is described below.

11.4.10 Sealing the Penstock Leak

The leak was demonstrated to be emanating from a pvc drain which had been installed during construction, left in position and had been inadequately grouted. The rate of leakage was varying with time but was generally increasing and although it was still well within the capacity of the station pumps, it was recognised that it would have to be sealed sooner rather than later. It was decided that the best approach would be to plug the leak by forcing grout into it against the penstock pressure. This process would require the injection of first water and then grout into the rock at a pressure above penstock pressure. It was recognised that this could result in a range of consequences from a modest increase in leakage to a catastrophic collapse of concrete and rock into the MIV gallery. From the outset the project was approached with a risk assessment perspective and the detailed considerations are given in Appendix B.

11.4.11 The Sealing of the Penstock Leak and Development of Risk Assessment

As with the MIV bearing change, the sealing of the penstock leak was a major project with the potential for a catastrophic outcome. Once again the project demanded and received the highest management attention. The problem was becoming progressively more severe and it was assumed that the increasing flow rate would accelerate the erosion, causing the flow rate to increase further.

The potential for failure of rock and concrete surrounding the penstock area, leading to collapse, was by far the most significant safety and commercial risk. The most

practicable alternative method, involving working from inside a de-watered penstock carried its own risks of damage to the lining and would have been very costly as well as involving the considerable commercial penalties of an extended outage. Seen from the standpoint of the CEGB, it is perhaps likely that they would have elected for the alternative approach. It is clear that PSB were strongly influenced by the new commercial pressures during their assessment of the options, just as they were in the case of the MIV bearing change.

The technical approach to sealing the leak was systematic and meticulous. The approach harnessed the knowledge and experience of the technical staff at Dinorwig as well as using external specialist advice. It is possible to criticise the simplistic approach of arriving at the Hazard Rating Number when applied to a significant technical problem, as well as the meaning of the number itself. It should also be noted that no specific assessment was made from the human reliability aspect. The approach remained purely technical resulting in an extremely thorough procedure. Nevertheless the methodology clearly served to identify the hazards and to concentrate attention effectively on the probability and frequency of exposure and the number exposed, as well as the maximum possible loss. In fact effective engineering controls were adopted for most significant risk, by drilling relief drains, by taking up the pressure in stages with dwell intervals and by close monitoring.

It may be noted that the first MIV bearing change took place in 1994 and the leak sealing in 1996. It is noted in section 8.4.7, that the MIV bearing change project was initiated at a time when risk assessment was little used or understood in PSB. The approach to the leak sealing project illustrates certain aspects of the evolution of the safety culture of PSB. In this case the risk assessment was produced in-house and was based on the NGC Code of Practice GS-MP9, a document which few in PSB acknowledged in 1994. By 1996, all supervisory, technical and managerial staff were aware of risk assessment, a risk assessment seminar had been delivered to senior staff by Professor R T Booth, further in-house risk assessment presentations had been given to staff, an internal risk assessment policy document had been issued and the recently appointed safety advisor had made a computer based risk assessment pro-forma available to all staff.

A further example of the developing approach to risk assessment is provided by the following :

A planned outage had been arranged to allow various tasks to be undertaken and it was intended to use the opportunity to lower an ROV down the HP shaft to inspect the repair. In the event the inspection did not take place because the ROV hydraulics failed and the operating contractors could not overcome the problem or produce a substitute ROV, during the period allowed for the outage. As a result, First Hydro had reviewed the contractual arrangements for a re-scheduled ROV inspection in an attempt to ensure that such a failure did not occur again. They were now insisting on the presence of a supervisor who was known to them and that this supervisor should be present throughout the work. They were insisting that the ROV was thoroughly tested in Aberdeen before being sent to Dinorwig and they had introduced a £50k bonus for success and a £50k penalty for failure.

Risk analysis had also revealed that in the event of a 400kV fault during the inspection would result in a 1kV voltage differential between the penstock and the top of the mountain. Such an event could cause currents which may lead to inadvertent welding between the ROV and the penstock. In response to this risk, it had been decided that the inspection would only take place if the lightning risk were low (determined by an Electricity Association national network of lightning detectors) and the wind speed were less than 30 mph so that the probability of overhead line faults was low.

11.4.12 Organisation and Management

During the period from March 1995 to February 1997, the managing director had accepted a non-executive directorship (with Mission's approval), of a Las Vegas based hospital group and he had been appointed as the Managing Director of Mission Operations UK. These appointments had meant that he was increasingly remote from the Directors of First Hydro and this had introduced a very tangible tension into the relationship. The Commercial Director had been made General Manager and was effectively in day to day charge of First Hydro. He had borne the brunt of the sale process and the other Directors felt that he should have received more recognition and reward for his efforts.

The manager at Ffestiniog said that the Directors had indicated that they intended to do more directing and leave the management to others coupled with a no-blame culture. In fact all the Directors freely admitted that they did too little directing and it was difficult to see how this dilemma could be resolved in what is a relatively small organisation in which appointing more managers to undertake their present duties would make the management structure top-heavy.

It was clear that Mission were allowing the existing management team to run the operation. No specific Mission systems had been introduced and Mission had not changed any existing systems. Although First Hydro was capital intensive, it had no significant financial reserves and it was clear that Mission regarded it as a stand-alone operation. It was admitted by the Directors that the real change was that they had lost the NGC financial safety net and they had to make their own arrangements for many aspects of the business such as treasury arrangements for handling their very large cash flow movements.

The only sources of income remained Energy Sales (which could be very profitable), Contracts for Differences (where they were seeking longer term contracts) and Ancillary Services (where they had only one customer and a one year contract). It was said by one of the Directors, that Mission had some difficulty in understanding the volatility and unpredictability of the business. The fact that they had exceeded all the targets set by Mission gave them a difficulty, since Mission could automatically assume that the targets had not been sufficiently severe. International Hydro had now been swept up quite logically into Mission, which was a company specialising in new international ventures. From the personnel perspective the break with NGC was welcomed as it resulted in their being able to adopt whatever policies were sensible for the First Hydro. They could now recruit if they wished to, without being subject to an arbitrary headcount figure, imposed from outside.

11.4.13 Public Relations

First Hydro continued to maintain a high public relations profile. As well as purchasing the Museum of Wales at Dinorwig, First Hydro was to be a major sponsor of a Celtic Village development (a form of theme park) adjacent to the Ffestiniog lower dam. A multi-media public relations CD ROM package was also being developed.

11.4.14 Preliminary Report Produced for First Hydro by Researcher

Following the submission of the preliminary report (reproduced in Appendix C) and its acceptance by the First Hydro executive, it was discussed at both the Ffestiniog and Dinorwig HESACs. All the recommendations were accepted in principle and it was agreed to establish a sub-committee comprising all the safety representatives and the manager of Ffestiniog (chairman), to consider the report. The sub-committee reported back to the HESACs with its recommendations which are reproduced below:

Safety Culture Sub-committee - List of Recommendations: (verbatim)

- Review the STARS system.
- Regular informal meetings between each Department and its relevant Director for open discussions (dispel rumours).
- HESAC minutes from both HESACs should be issued to all HESAC members and should be an agenda item at both HESACs.
- Safety communication to staff should be on paper, preferably pink, initially to each location manager who should then disseminate as appropriate.
- Memo to all staff explaining ISRS
Seminar on ISRS at each site
Brief description of ISRS in the Newsletter
- All additional work during outages to be co-ordinated through the Planning Department.
- Any changes to work plans should be communicated to all relevant persons as soon as possible.
- Notice stating the number of days since the last lost time accident to be erected at all sites.
- Enquire into EME's method of accident reporting/statistics and consider its benefits.
- Review the Safety Rules.
- All plant related job cards to be directed through the Shift Engineers for decisions on safety documents.
- More feedback to all staff on the results of both internal and external emergency exercises.
- Internal emergency exercises are carried out when guides are on site.
- Stress counselling, if required, following incidents, or when requested.

- Stress awareness and management seminars.
- Individual discussions with Nurse, Doctor, Chaplain or Welfare Officer regarding stress should be confidential if requested.

11.4.14.1 Comment on the Sub-committee Recommendations

It should be noted that the recommendations in the Preliminary Report produced for First Hydro, were deliberately non-prescriptive. It was emphasised in the report that the detailed approach should emerge *from the collective consideration and involvement of the staff and management*. It was also suggested that *a piecemeal approach would be inappropriate and the real need is for the implementation of a carefully considered strategy, embracing all relevant issues*. The report identified the basic requirement as a need to *influence attitudes and behaviour towards the acceptance and expectation of higher standards*. For these reasons, the recommendations in the report were set out as a methodology for promoting a change in the safety culture, by concentrating on raising safety and risk awareness and establishing staff/management implementation teams, with responsibilities and resources (budgets), in order to promote ownership and commitment.

It will be seen from the list of recommendations of the sub-committee that they identified each of the issues commented upon in the report and produced a piecemeal response. The basic issue of changing the safety culture was ignored. It is a particularly fine example of tackling the symptoms but ignoring the disease. The sub-committee reported that they had accepted the report but in fact, without being aware of it, they had rejected the analysis.

11.5 Views of Change

The views of a range of individuals was sought on what had changed over the period covered by this study. All those who were questioned expressed themselves pleased at the final outcome of the sale to Mission although not all seemed to have a specific reason. It may be reasonably assumed that the general feeling was associated with the end of a long period of uncertainty together with having avoided being owned by Scottish Hydro who, it was widely believed, would have removed the existing management and many staff. The Company had retained its identity under Mission

ownership. It was also clear that Mission had not imposed any changes upon First Hydro other than additional members at board level. Some control engineers expressed the view that the Directors seemed more nervous, although this was in the immediate aftermath of the purchase and the Directors themselves were certainly reserving their judgement at that stage, although they were in no doubt that the sale outcome was the best they could have hoped for. The bidding process had removed any respect they may have had for Scottish Hydro, who they believed, had demonstrated little competence.

A view expressed by a number of staff was that "*the impact of Mission will depend on the profit delivered.*" Some First Hydro shop floor staff had taken part in a golf match with the US Directors and reported that "*they were not concerned with status - very different to NGC.*" Managers believed that there was more emphasis on safety and believed that "*the Managing Director wishes to have a good public image for the Company and safety is important.*" Training was now more systematic ... "*there is a specific training budget of £120k/year and more emphasis on safety.*"

A number of senior staff believed that there was more empowerment but that this meant that you had to be prepared for staff to make mistakes. From the procurement function the view was expressed that "*there is more pressure, more is demanded of people but response times for tendering and procurement are much quicker...money goes further.*" Both the procurement and the personnel functions welcomed the freedom from externally imposed bureaucracy and the restrictions they were used to in NGC and the CEGB.

The fundamental difference volunteered by all the senior managers was that they were now a small company and were "*on their own*" even under the ownership of Mission. They had to be self-sufficient and had lost the financial security of being a small part of NGC or the CEGB. They would stand or fall by their own performance and this had sharpened all their management efforts. In the past, many major decisions would be taken externally but now they must make their own investment and refurbishment decisions and they could directly influence the amount of generation they obtained by their own policies on cost control, pricing and availability. This had caused them to be innovative (e.g. "*the CEGB would not have undertaken MIV bearing replacement without de-watering the shaft.*") It should be noted that this technique was developed

under NGC ownership and is therefore associated with the commercial imperatives brought about by privatisation rather than self-sufficiency. *"In the CEGB scant attempts were made to quantify the costs of each machine. Now we have detailed knowledge of the financial and commercial consequences and a very good understanding of the implications of costs and availabilities. We know the worth of all plant for every half hour period."*

The plants were performing better in terms of efficiency, productivity, availability and response times and staff numbers were being reduced. Much of the staff reduction was being facilitated by technical change and automation and it was acknowledged by managers, that PSB/First Hydro, had been insulated from the harsher downsizing of NGC because of the nature of its operation and because it continued to be profitable. Staff were now routinely provided with commercial data which included the profit for the previous day and there was no doubt that there was a much higher level of awareness of commercial issues amongst staff than would have been the case before. One new feature which had raised the level of commercial awareness (and in the view of Directors), was profit related pay.

There was a clear appreciation of the risk exposures faced by the business in relation to contracts, the differential pool price and the risk of plant failure. In respect of the latter, the issue of 25 year 9% Bonds had resulted in a complete survey of the plant and a review of the approach to the future of the Company.

11.6 Impressions of the Safety Advisor

The Safety Advisor had no previous knowledge of the Electricity Supply Industry and was appointed in June 1996 from a previous position as a colliery manager. His impression of First Hydro in May 1997 was that *"the basic problem is insufficient safety awareness especially amongst middle management."* His view was that *"the safety culture is not negative but it is insufficiently positive."* It is interesting to note that this view was consistent with that of the researcher.

11.7 Summary of the Changing Situation

The second questionnaire had revealed an increasing divergence between supervisors and the supervised, in which supervisors' responses suggested a stronger safety culture

and the responses of the supervised, a weaker safety culture. Whatever the reasons for this may be, a number of background factors may be identified within the changing environment.

There would be some factors that one would expect to raise morale. The outcome of the sale process had ended a long period of uncertainty and concern, not least over continued future employment. One would expect any satisfaction from this factor to be greatest amongst the managerial and technical staff whose position was most at risk from a different outcome. (i.e. largely the supervisors group). The satisfaction would be particularly great amongst the senior management, who not only had the most to lose but also had been most personally involved in the negotiations and therefore in achieving the outcome.

Under the ownership of Mission, First Hydro had greater independence than the two stations had ever previously enjoyed. The *hands off* approach of the owners meant not only that more control resided in the local management than before but with the financial and technical safety net of the CEGB and NGC no longer there, the Company had to be self-sufficient. These factors might be expected to lead to greater satisfaction amongst senior staff, especially when coupled with the continuing high level of profitability of First Hydro. On management performance indices of efficiency and productivity, First Hydro was continuing to improve. This factor might reasonably be expected to raise morale, again especially amongst the management/supervisory group. The successful development of the technique for changing the MIV bearings and the sealing of the penstock leak (described in detail in Appendices A and B), could reasonably be regarded as technical triumphs and would further enhance the sense of achievement, primarily within the technical/managerial staff group.

Ffestiniog was generating more than it had done for many years which also should tend to raise morale there but set against that was the policy of de-manning the station. The process seemed to be being handled with the greatest care and sensitivity but the effect of this on a significant group of staff, very largely the supervised, can only have had a net negative influence, both through the effect on their personal lives and on their sense of worth. It was clear that the faith of a significant proportion of the staff in the effectiveness of communications was at best, lukewarm. STARS remained deeply

unpopular with both the assessors and the assessed and strenuous efforts were being made to modify the system to make it more palatable, including the predictable device of giving it a new name.

In respect of matters specifically related to safety, it was evident that the appreciation and understanding of risk assessment was substantially stronger than before and although risk assessment remained weak in relation to routine hazards, the situation was at last improving. Risk assessment progress owed much to the development of the techniques for dealing with the MIV bearings and the penstock leak. This had also ensured a better understanding of the compatibility of the risk assessment approach to both safety and commercial risks. ISRS was being reborn at Ffestiniog and enthusiastically promoted by the manager. The situation at Dinorwig in relation to ISRS, was less clear. Although accidents had happened between the first and second questionnaires, the accident frequency rate had been reduced to zero by mid 1997.

Substantial investment was being made at both stations to improve the working environment and many of the changes would result in safer conditions but the evidence from site observation and inspection indicated that this was not accompanied by changes in attitude and behaviour. The report submitted by the researcher had been *accepted* but in fact the response had been superficial. All the initiatives taken had resulted in cosmetic changes and the deeper message of strengthening the safety culture had been missed.

Chapter 12

DISCUSSION AND CONCLUSIONS

Life is the art of drawing sufficient conclusions from insufficient premises.

Samuel Butler 1835-1902

12.1 Introduction

Previous Chapters have described, in some detail, the nature of the evolving organisation that became First Hydro and the forces, influences and events that moulded its evolution. This Chapter comprises an attempt to relate the evolution of the organisation to the evolution of its safety culture and to assess the relevance of the safety culture indicators identified in the ACSNI Report. The conclusions are summarised in section 12.14.

It is difficult to interpret the present without an understanding of the past. This research emphasises the crucial role played by the inherited attitudes, values and beliefs within the organisation and the difficulty, for better or worse, of changing those characteristics. This discussion therefore begins with a brief summary of the main events in the evolutionary process, which have been detailed in Chapters 4, 5 and 6, with an update in Chapter 11. The evolutionary process is summarised against a time line in Figures 9 to 11.

12.2 Evolutionary Overview

The First Hydro organisation, based at Bala House, Ffestiniog and Dinorwig, is now (1997), a wholly owned subsidiary of Mission Energy, a US based utility company. First Hydro has undergone a dramatic organisational evolution in a relatively short time. Ffestiniog was commissioned in 1963, a product of the Generation Design and Construction Division of the CEBG and Dinorwig was the product of a similar background in 1984. Both stations were operated by the CEBG as part of a large portfolio of power stations until 1990 when the two power stations were made part of the newly created NGC. At this point the stations were formed into a self-contained Pumped Storage Business within NGC, with an operational headquarters established at

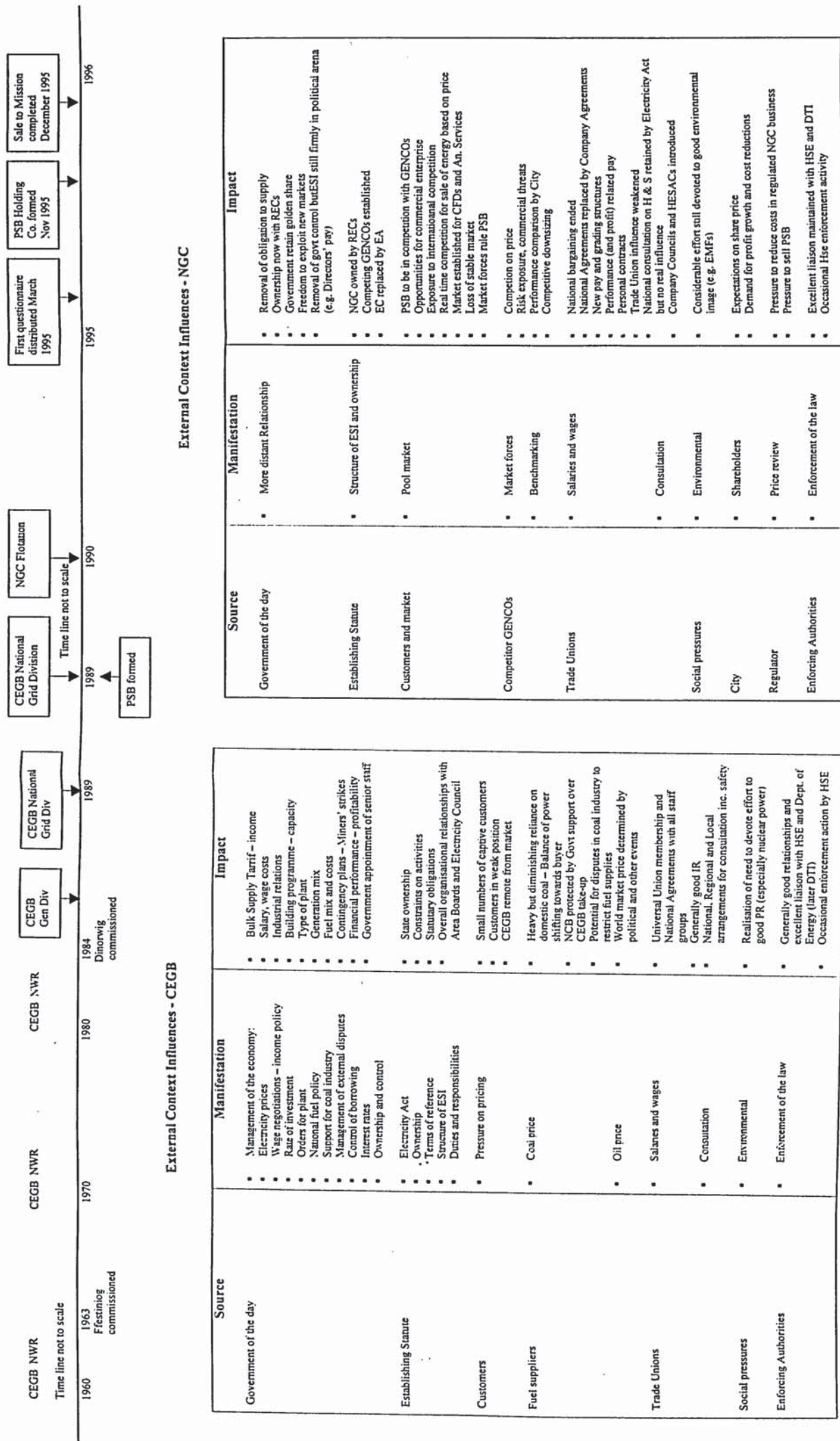
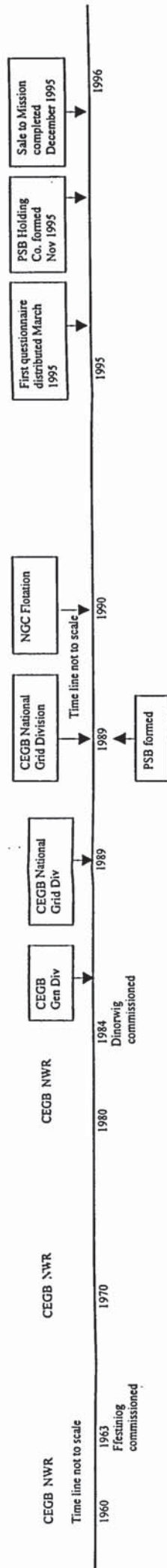


Figure 9: External Context Influences



Nature of CEGB Organisation

Structure	Culture	What Was Important
<ul style="list-style-type: none"> Highly structured and stable Bureaucratic Hierarchical command structure Fixed grading structures Centralised Formal relationships Elaborate, layered negotiating and consultative arrangements Monolithic Strong Regional power base Internal technical competition Meeting oriented (committee management) 	<ul style="list-style-type: none"> Engineer dominated Technocratic Technical integrity Belief in technical excellence Technically arrogant Insular Given to technical and performance standards Internally technically competitive Centralist Formal Lavish Think big Conservative Achievement oriented Strong belief in role of line management Good employment practices Good industrial relations Good terms and conditions Belief in secure and stable future Lifetime career commitment for most staff Strongly stated belief in importance of Health and Safety Clear sense of purpose and public duty Pride in organisation and role in society Rules, systems and procedures dominated Low appreciation of human factors 	<ul style="list-style-type: none"> Engineering driven i.e. <ul style="list-style-type: none"> Efficiency Performance Output Availability Safety (technical) Societal contribution (e.g. miners' strike)

Nature of NGC/PSB Organisation

Evolving Structure	Cultural Objectives	What Was Important
<ul style="list-style-type: none"> Creation of separate Business Divisions and PSB Profit centres not cost centres Less hierarchy Shorter lines of communication (de-layering) Internal competition between Divisions More benchmarking Devolution of authority from centre Relationships between Businesses governed by SLAs (internal market) Company pay and grading scheme Performance related pay Eventually asset ownership separated from operational responsibility 	<ul style="list-style-type: none"> Market driven i.e. <ul style="list-style-type: none"> Profit orientation Responsive to customers and market, both internal and external Innovative Less upward referral More devolved authority and responsibility Empowerment Emphasis on performance and quality Strongly stated belief in safety Competitiveness Minimum direction from the centre Cultural change by exhortation (Chairman's Values) and restructuring PSB Market Engineering driven i.e. <ul style="list-style-type: none"> Dependent on contracts and Pool price Engineering approach largely unchanged but innovation stimulated by commercial pressure Good IR a priority Very strong engineering influence 	<ul style="list-style-type: none"> NGC <ul style="list-style-type: none"> Profit New business Innovation Outputs (not inputs) Company image PSB <ul style="list-style-type: none"> Profit Availability Efficiency Output Safety (technical) Image Innovation (commercially related) New Business (no effective return) Cost control

Figure 10: Nature of Organisation

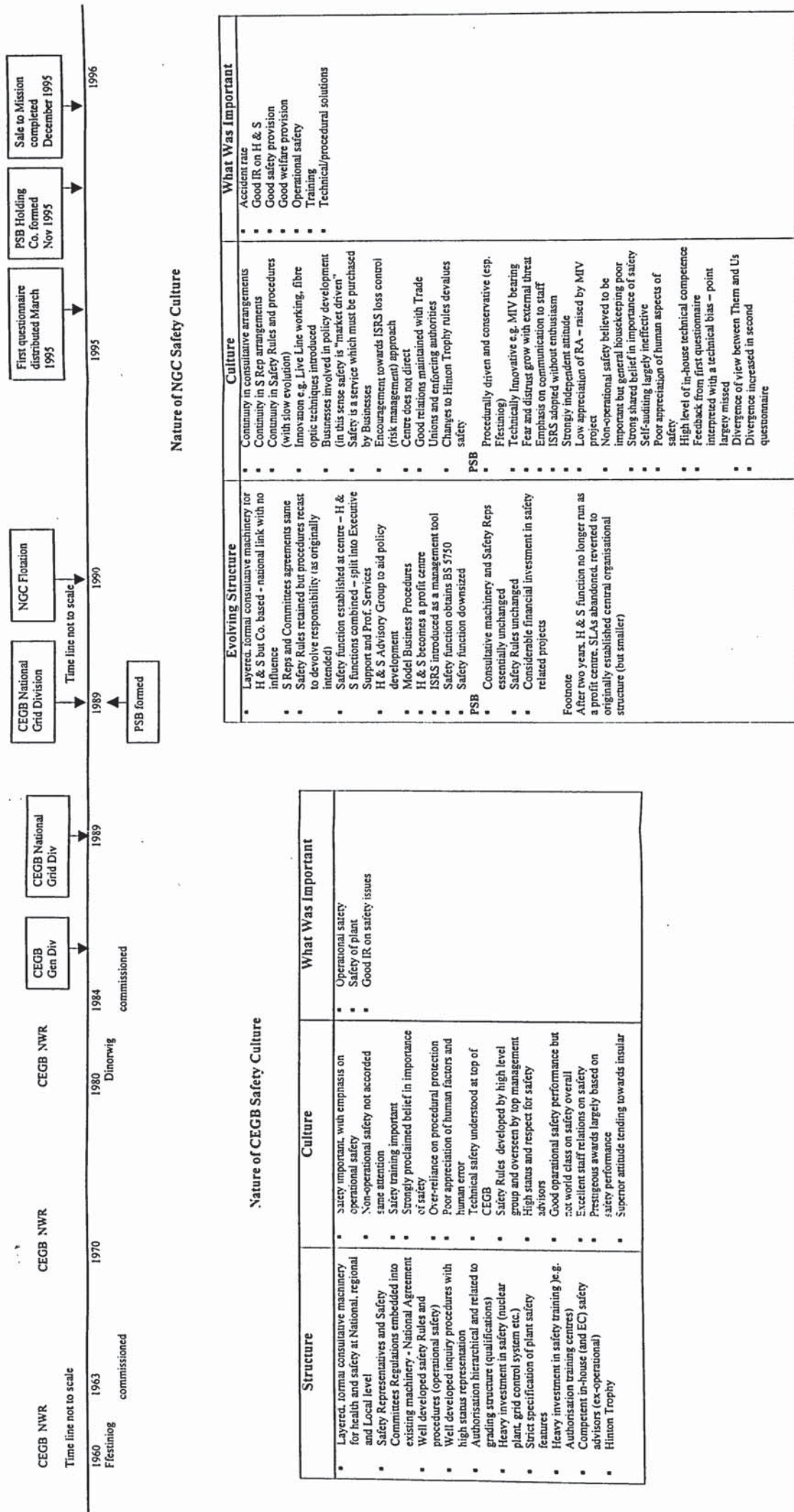


Figure 11: Nature of Safety Culture

Bala House. PSB was thrust into a competitive market with the other large generating companies, all newly created from the former CEGB. PSB continued to operate as a business within NGC until it was de-merged in 1995 and for a short time, was owned directly by the RECs through the PSB Holding Company until, following a trade sale, it emerged as First Hydro, a wholly owned subsidiary of Mission Energy.

Several significant factors and events must be noted.

During this evolution, First Hydro went through two prolonged periods of uncertainty. The first of these was the period leading up to and during privatisation and the second was the period leading up to and during the trade sale. It is clear that the organisation was overwhelmingly engineering driven until 1989 and thereafter the business was market driven. It is evident that the cultural roots of First Hydro are in the CEGB. All of the Executive Directors are former CEGB employees and all of them have retained their positions through de-merger and sale and into new ownership. The continuity of staff through the evolution is significant. Almost all the professional technical staff, the great majority of the supervisory and the industrial staff and a significant proportion of the administrative and clerical staff, are ex-CEGB. Most staff had worked for their entire careers in the CEGB prior to the formation of PSB. A minority of staff does not have a CEGB background, mainly in commercial and financial roles, as well as younger staff who have joined the organisation since the formation of PSB. It is to be expected that the career history of the great majority of the staff and particularly the senior staff, will be a significant factor in tending to sustain the cultural influence of the CEGB. To the extent that the culture of an organisation lies in the deep seated shared attitudes, values and beliefs of the members of the organisation (Deal & Kennedy, 1982, Rousseau, 1988, Schein, 1985, Waring, 1993) and that they are difficult to change (Booth, 1986, Johnson, 1991, Golzen, 1987), it will be apparent that these conditions are likely to predispose the CEGB successor organisations to very much the same culture. It may also be expected that the long established and stable cultural values of both managers and staff would, in any event, be a major constraint to change (Buchanan & Huczynski, 1997).

It is appropriate to consider what conclusions can be drawn, from a more detailed examination of the culture of First Hydro and its origins in the CEGB, in relation to the forces and influences, in both the inner and outer contexts, which may have moulded

that culture. This discussion will be based on a consideration of the relevance to the evolving culture, of each of the main factors identified as a positive indicator in HSC, (1993). Arguments used will be based on the evidence set out in this thesis, which relate to the period prior to the formal and systematic collection of site data, as well as the evidence gathered between 1994 and 1997, from informal discussions, structured interviews, direct observation and the responses from the two issues of the questionnaire. Throughout this analysis it is important to note that the evidence upon which to base any conclusions is stronger during the period of formal data collection and weaker prior to that.

12.3 Senior Management Commitment

The importance of the commitment of senior management to safety and the perception of the workforce of the sincerity of that commitment, was identified by Brown & Holmes, (1986) and Dedobbeleer & Beland, (1991). The importance of management commitment has been constantly emphasised by the HSE (1976, 1981, 1991), as well as HSC, (1993) and CBI, (1990). HSE, (1991), stress that safety should be a Boardroom issue. It is also self-evident that management commitment is a factor which impacts on many of the other factors such as communications and training etc. which are discussed below.

We have seen that the senior management of the CEGB emphasised their commitment to safety, although it is acknowledged that in keeping with their technical bias, it was operational safety that was stressed. Their education and experience made them well equipped to understand safety in scientific, technical and procedural terms. Direct evidence is provided by the real and meaningful involvement of the most senior CEGB managers in the development of the safety rules and the status and value placed on their safety organisations. A very high profile and status was also given to their Board of Inquiry procedure, although it must be acknowledged that the outcome of such inquiries was likely to be an amendment or an addition to a procedure; an example of the stop rule (Rasmussen, 1987).

Although these examples represent tokens which certainly imply a commitment to safety, no other more direct evidence is available to indicate the true status of the deeply held attitudes of the CEGB management. It may perhaps reasonably be assumed that the

predominantly engineering and operational background of CEGB senior management, impressed upon them the importance of safety but particularly in the context of the technical systems and procedures with which they were so familiar. The ever-present nuclear debate would also serve to reinforce these convictions. At the same time, it is likely that the technocratic background and environment would not be conducive to a keen awareness of the human behavioural context of safety. In fact there is much evidence to suggest a strongly entrenched functionalist world view (Waring, 1996), which underestimates the complexity and importance of the human dimension. Turner et al., (1989) referred to the engineer's "impoverished" view of the social dimension. As the organisation evolves into NGC, we have the stated commitment of senior management to safety but also the availability of more direct evidence which might indicate that the commitment is not truly internalised. For example, the drafting of the Chairman's Objectives and Values without initial reference to safety, the redrafting of the Hinton Trophy rules and the terms in which the Company's objectives were expressed in the Business Plan, entirely in terms of profits and dividends and the absence of any reference to safety in the Annual Report for 1993/94, all made it increasingly difficult to sustain the belief that safety was equal in importance to the other primary objectives of the Company. This is not to say that the stated commitment was insincere or that it was necessarily any less than that of CEGB senior management. It is merely to indicate that there is evidence that casts doubt on the strength of the core attitudes and beliefs.

The corollary of management commitment is the perception of the workforce of that commitment. The workforce may tend to be suspicious of management's true intentions but particularly so at a time of dramatic change. As Turner et al., (1991) have pointed out, management initiatives may be perceived as fads and fashions which usually go as quickly as they appear. Equally the workforce will base their behaviour on what they perceive management really mean (Donald & Canter, 1993). The workforce will be quick to identify any suggestion of insincerity. This poses practical difficulties for any company seeking to make major organisational changes at the same time as promoting what it believes to be positive cultural change. The NGC Blueprint referred to enhancing the role of the individual but at the same time, many of the individuals were experiencing doubt and uncertainty and anxiety about their jobs. The NGC Communications Survey (Lowe & Carrington, 1994), revealed the depth of mistrust and

disenchantment with the organisation and its management. It must be noted that PSB emerged from the NGC survey, in a much less negative light than the rest of NGC. Both questionnaires issued as part of the research, revealed strong agreement from the workforce that PSB management were genuinely concerned about safety and welfare, whilst at the same time, there was very weak agreement at best, to the proposition that the workers trust the management. Direct observations and interviews strongly confirmed the sincerity of the management commitment to safety but the relative lack of trust in management is hardly surprising in view of the extended period of external threat to their future, which far exceeded that to which the staff of NGC were exposed. It was found, (as reported in Appendix C), that one problem was

“an acceptance of standards that were believed to be tolerable and an inability to identify what further measures can be taken to effect an improvement. It is not a matter of whether a commitment is sincere, or even visible, which it clearly is, but of how far the commitment goes.”

Reflection on this dilemma suggests that the true nature of the difficulty of resolving the problem of poor housekeeping was in the fact that it was a human behavioural issue and was an area in which the engineering managers were relatively ill at ease. Procedural solutions did not seem to work and exhortation was ineffective. This perhaps, is an illustration of the weakness of the functionalist approach.

Overall there is no evidence to suggest that genuine management commitment to safety and welfare is other than very strong in PSB. Certainly the perception of the workforce is that management are very strongly and sincerely committed to safety and welfare.

12.4 The Style and Visibility of Management

The importance of the style of management on a positive safety culture was demonstrated by Brown, 1992, Smith et al., 1978 and de Michiei, 1982. The general belief is that a more humanistic style, which is more employee centred and caring, is more likely to be associated with a good safety performance than a production centred and controlling or authoritarian approach. The preferred styles are more likely to be associated with a participative culture, with greater employee involvement and an openness (Gaertner et al., 1987), which will foster trust.

Management style must, to some extent, be a function of the nature and structure of the organisation and it has been noted that the CEEB technocracy was a hierarchical, role based organisation, which was reflected in its grading structures and career progression. Management style was relatively formal and was based on elaborate committee structures. It has been noted that the organisation was not as rigid as this implies e.g. in emergency response and crisis management (La Porte, 1989, Ledger & Sallis, 1995).

The industrial relations machinery of the CEEB and the ESI, specifically the consultative machinery, was the basis for a considerable degree of worker involvement and it underpinned staff welfare as well as the well developed health and safety functions. All of this was carried forward into NGC although the external context was driving internal organisational change and downsizing, with the result that much of the trust in management was no longer evident in the NGC Communications Survey (Lowe & Carrington, 1994). In fact it had been replaced by mistrust and suspicion.

Staff within PSB were insulated from the harsher aspects of the downsizing and other changes in the parent organisation, by a number of factors which are relevant to many of the different aspects being considered in this Chapter. PSB was a separate business within NGC but was also a different business, unique in NGC, a generator. As such it had to be insulated by Chinese Walls. The first PSB General Manager encouraged and fostered an independent attitude. The business was remote from headquarters and was small and self-contained and finally it was in Wales. All these factors insulated PSB but perhaps its greatest protection was that it was very profitable.

NGC and PSB inherited the CEEB grading structure, although this was changed by NGC, to a single-spine Company structure, which removed the distinction between different staff groups. NGC and PSB also inherited the modified consultative machinery, which was operated in much the same way as before and many examples of PSB management openness in the use of this machinery are noted elsewhere in this thesis. The questionnaire results indicated that staff believed they could talk openly to management about safety problems but there was much less support for the proposition that they were meaningfully involved. This again is very likely to be a function of the uncertainty to which all of PSB was subjected.

The importance of management visibility by walking about is stressed by Gaertner et al., 1987, although management visibility must, to a large extent, be associated with the style of individual managers. CEGB power station managers were generally very well known to their staff but within NGC, reorganisation leading to fewer managers and larger management units, cannot have helped the visibility of individual managers. In PSB, staff claimed that the second General Manager was less visible than the first, which must partly be due to a difference in personal style but it is also likely to be a function of the external focus, brought about by the flotation and sale process. Although there is no evidence to suggest any overall marked change in management style in PSB, the NGC communications survey provides powerful evidence of a change in style in the manner of implementing change.

12.5 Communications

The importance of effective communications, founded on mutual trust, is stressed by HSC, 1993. Other sources emphasise the need for frequent and informal communication (Gaertner et al., 1987, Smith et al., 1978, DeMichiei, 1982). HSE stress the importance of communication (HSE, 1991) and it is equally important that it should be effective (Ryan, 1991, Horbury, 1997) and two way (Booth, 1993). An obviously important aspect of safety communication is that it must provide an information mechanism which allows lessons to be learned and experience to be captured (Glendon, 1995, Toft, 1992). Routine communication in the ESI prior to 1989 was generally formal and well structured and the stability of the organisational network facilitated informal contacts, particularly in the areas of functional specialisms. It has been noted in Chapter 6 that the greater emphasis on intellectual property and commercial confidentiality placed this vital aspect of communication under threat but that the threat was successfully averted and guidelines were agreed for the sharing of safety information. It was also noted that suggestions were being made by newly appointed legal specialists that formal inquiry reports could prove to be a liability in later litigation and that the benefit of the formal inquiry procedure was questioned. This was a matter of great significance for a learning organisation. The suggestions were successfully resisted and the inquiry system was retained, albeit with some modification in NGC. On the more general aspect of communication, the NGC survey demonstrated a situation in which communication had come to be distrusted by the workforce at a time of uncertainty, fear and anxiety.

The data from PSB provide many examples of management making considerable efforts to communicate effectively with staff and yet the questionnaires indicated that staff did not believe that communication was effective or prompt. Although the situation was much better than in the rest of NGC, it was far from satisfactory. Interestingly staff believed that safety communication was good in relation to accidents. It should also be noted that the quality of supervisors' instructions was not believed to be particularly good.

It has to be acknowledged that the management of PSB faced a severe problem in maintaining the trust of staff in the communication process because of the period of uncertainty surrounding de-merger and sale. This was the issue of greatest concern to all staff. Management were not in control of events or of their own destiny. The more they tried to communicate, the more the staff probably felt doubt and uncertainty. In fact it may be that the communication process was, to an extent, counterproductive in that it emphasised the uncertainty in the situation. It is perhaps both interesting and remarkable that staff trust in management, in respect of safety and welfare issues, remained extremely strong.

There seems to be little evidence of any markedly different approach to communication in PSB to what would have been expected in a well managed CEGB location. PSB was perhaps doing better than might have been expected, given the prevailing circumstances and it had avoided the worst problems of NGC.

12.6 Pressure for Production

It has already been noted that there was a common assumption by most staff that safety would suffer as a result of privatisation but this was matched by a determination on the part of the NGC Executive in 1990, that this would not happen. No evidence has been noted in this thesis, of production being given precedence to safety, either pre-1989 or since. There was an assumption amongst the staff of PSB that privatisation would lead to a lowering of safety standards but none of them could produce any evidence to support this assumption. In fact the accident rate improved. In questionnaire responses, staff at PSB were emphatic that safety was not sacrificed to production. It has been noted that safety policy statements issued by NGC and mirrored by PSB, claimed that safety was equal in importance with the other primary objectives of the Company but

some evidence has also been noted which casts doubt on this claim. Since behaviour tends to be based on perceptions of what is expected (Donald & Canter, 1993), any suggestion that the Company is insincere in its stated safety policy would be likely to have an adverse impact on managers and staff. No evidence has been identified to suggest that the attitudes of managers in NGC's core business was any less supportive of safety than previously. In fact they, as much as anyone, were adamant that safety would not suffer. The staff of PSB stressed that they believed that their management were even more concerned about safety than before.

The data did suggest that there were increased pressures on production in PSB and that every effort was being made to tighten deadlines but at the same time, staff claimed that time pressures were not excessive. Staff at PSB also claimed that the safety rules were practical and were applied in full. Nevertheless, some evidence was noted of routine minor infringements of the rules and was evidence of the frustration of conscientious staff at what they saw as an unnecessary requirement. A problem with their locus of control (Rotter, 1966). There was no evidence to suggest that safety had suffered as a result of production pressures throughout the period covered by this study. Rather there was evidence that safety standards in PSB were improving. There were several instances of major expenditure on schemes to improve the work environment. This was perhaps most marked at Ffestiniog, on which there had been no long-term investment for some time. In this respect, the financing of the sale of First Hydro to Mission, partly by 25 year bonds, was significant in extending the expectation of plant life and consequently of increasing capital investment.

12.7 Training

It has been recorded that considerable financial and physical resources were devoted to safety training by the CEGB and this was particularly true of operational training. Competence was important and was emphasised by the safety rule authorisation procedures. The importance of training and competence are stressed by the HSE, (1990), HSC, (1990) and by Zohar, who found that training was highly predictive of safety performance. The CEGB emphasis on training was carried forward by NGC and it was found in PSB that more staff were being supported on training courses than ever before. The questionnaires revealed a very powerful belief amongst staff, that they had

received sufficient training and an equally strong belief that they were provided with the equipment to do their job, especially safety equipment.

Such perceptions may indicate a considerable element of staff satisfaction but the fact is that there were a number of areas in which training was deficient. Risk assessment training was non-existent at the start of data collection as was any real understanding of ISRS in a location which had “adopted” the system. The fact that staff perceptions were particularly good in the area of training and that management commitment to training had never been greater, whilst there were evident deficiencies in training provision, is an indication that positive perceptions alone are not sufficient to demonstrate good standards, the perceptions must be well founded.

12.8 Housekeeping

One of the most intractable problems in PSB was the coexistence of very poor housekeeping standards and very good standards. Keenan et al., (1951), demonstrated the importance of a clean and comfortable workplace. The questionnaires revealed that staff generally believed that their workplace was clean and tidy. There is no evidence to suggest any influence on the issue of good housekeeping, from the changes in the external context that were taking place. The problem appeared to reside in long standing attitudes and behaviours of the staff of PSB, which were deeply entrenched and very resistant to change (Buchanan & Huczynski, 1997). This is another important example to illustrate the need for positive perceptions to be well founded if they are to be taken as an indicator of a satisfactory absolute standard. In a way this illustrates the central safety issue facing PSB. The problem is rooted in social behaviour and the engineering culture and inheritance was unable to see how to effect an improvement. It is suggested that the way forward is by means of a structured approach involving the workforce as set out in Appendix C. A very telling commentary on the safety culture of PSB, is provided by the reaction to the interim report. The management accepted the report and established a management/staff working party to implement it. Although PSB claimed to have accepted the report they failed to tackle the central theme (see section 11.4.12.1).

12.9 Job Satisfaction and Workforce Composition

Lee, (1997) has demonstrated that job satisfaction is a powerful predictor of accident history and therefore that it is an important element in a good safety culture. No direct evidence of job satisfaction pre-1989 has been cited, although the evidence of generally good industrial relations, good terms and conditions of employment, long tenure and an enlightened approach to dealing with plant closures, does suggest that job satisfaction was reasonably good. The NGC survey provides direct evidence of very low morale related to the process of reorganisation and the manner in which it was being implemented. In fact the NGC management style was now very different to the CEGB and the evidence suggests that the values of the organisation were no longer congruent with the values of the employees (Meglino et al., 1989).

Questionnaire responses gave every indication of reasonable job satisfaction in PSB in all areas except trust in management and worker involvement. It has already been stated that the scores in those areas were much higher than the rest of NGC and the probable reason suggested for the relatively low scores in these areas, is the uncertainty over the future of PSB and everyone within it. It is suggested that this must have been very corrosive, particularly as successive deadlines, for more information, came and went. NGC management and PSB management had no influence over this. Performance related pay was another manifestation of the changed environment which probably contributed to the lack of trust in management and the problems with STARS exacerbated the issue. Another source of widely expressed discontent was the issue of Directors' pay, which caused great offence.

A particular area of job dissatisfaction was the view regularly expressed by shift engineers that they were uncomfortable with the change in priorities from making electricity to making money. There was a strongly held view that this was a less worthy endeavour and it was clear that this troubled them. This demonstrates that the public service ethic was important as an aspect of the culture which gave daily reaffirmation and reinforcement of their personal and professional identities (Waring, 1996). The change of priorities had led to cognitive dissonance (Festinger, 1957).

Perhaps the most significant difference in the results of the second questionnaires, was a widening of the gap which had existed in the first set of results, between the

“supervisors” and the “supervised.” The supervisors, perhaps not surprisingly, tended to give more positive responses than the supervised but the responses of the supervisors were more positive the second time and the responses of the supervised, more negative. The explanation for a general negative shift might have been the continuing uncertainty but one must look for explanations which account for the differentiation in reaction.

For the senior management team the outcome of the bidding process was the best that the managers and staff of First Hydro could have wished for, in that it removed the threat of major job losses and maintained management continuity. Intensive efforts by the PSB management team had managed to secure for the staff, essentially the same terms and conditions of employment, pension arrangements, severance arrangements and had secured favourable terms for the staff in relation to the share save scheme. It also became evident that the new owners were adopting a *hands off* approach to their new acquisition. For the management team the outcome represented a considerable triumph after strenuous effort and for the workforce, a relief after months of worry. As a wholly owned subsidiary of a US company, First Hydro was removed from the direct influence of the City and unhelpful peer pressure benchmarking, whilst still being subject to market forces and to business targets set by Mission. The management of First Hydro was therefore free to run the business taking a long-term view, without having to follow fashion. The senior management team therefore had good reason to feel pleased at the outcome of the process into which they had invested so much personal effort. The technical staff had successfully completed the MIV bearing changes and the sealing of the penstock leak, two considerable pioneering achievements, with great commercial advantages. These achievements may go some way to explaining the more positive outlook of the “supervisors.”

One of the most striking features of the ESI in relation to organisational culture is the length of continuous service of most employees. It has already been noted that the staff inherited by NGC and by PSB were essentially long service CEGB employees. This was true at the highest level of management. It is in such long tenure employees that attitudes, values and beliefs would be most deeply entrenched (Buchanan & Huczynski, 1997). It is probably for this reason that NGC’s attempts to change the culture directly, by exhortation, were less likely to succeed. These included the reorientation seminars, commercial seminars and the Chairman’s Values. The seminars, which were attended

by managers, conveyed an implication that previously held values must be discarded and replaced by new values where profit was the primary objective. The managers were a select group who had succeeded exceptionally well in terms of the CEGB culture. Many believed the new values to be less worthy. The approach of NGC seemed to be driven by the concept of a *culture gap*, the difference between the existing culture and the culture they wished to espouse. Their efforts to close the gap were based on the prescriptive type of approach which Wheatley & Parker, (1996) argue, often results in failure.

In the aspects related to job satisfaction and workforce composition, PSB had inherited many aspects of the CEGB culture and avoided the influence of the changes taking place in NGC.

12.11 Monitoring and Review

It is interesting to note that post privatisation, all of the ex-CEGB companies sought a safety management system and all, quite independently, selected ISRS. Reference is made in the literature review to the experience of two of the other companies in relation to ISRS (Gibson & Low, 1994 and Davison, 1997), but the external context was a major driver in the choice of ISRS for NGC. Crucially ISRS is a safety management system which focuses on the control of loss. Loss is a direct deduction from profit and controllable loss was estimated at up to £20M/ year in NGC at that time. To replace such a shortfall would require an extremely large increase in turnover, which would be impossible to achieve. The new emphasis on profit led to an interest in the avoidance of loss and assisted the widespread acceptance of ISRS. It is also interesting to note that the Directors of NGC, true to their policy of not giving direction from the centre, allowed the location managers to introduce ISRS at their discretion. It is probably for this reason that NGC introduced ISRS almost universally and without great difficulty whereas ISRS was not really accepted in National Power, after being imposed top-down (Davison, 1997). Chapter 8 deals with the issue of ISRS in PSB where it was introduced later than any other part of NGC and reluctantly at Dinorwig.

The privatisation process therefore led to a heightened awareness of avoidable loss within NGC and the introduction of ISRS although it was introduced late and not entirely enthusiastically into PSB.

It has been stated by Canter & Donald, (1990), that the Hawthorne effect can have a positive outcome in the field of safety management research. On a number of occasions during the research, the author influenced the situation. E.g. In one such instance the author was questioned by the manager at Ffestiniog about safety rule audits and the information given to the manager prompted him to change his procedure.

12.12 Risk

The perception of risk must be a key factor in any safety culture. A reasonably accurate perception and assessment of risk must be a prerequisite if people are to work safely (HSC, 1993). No absolute assessments of risk have been attempted in this thesis and it is therefore not possible to compare individual risk perceptions with actual risk as was done by Hale, (1971). Nevertheless, one of the most significant issues considered is the development of the appreciation of risk assessment within PSB.

Chapter 8 records that knowledge of risk assessment was minimal in PSB for a considerable time after the start of the research (June 1994), in spite of detailed advice having been issued from NGC Safety Branch in response to legal requirements, in September 1994 (NGC, 1993c). Chapter 11 records that knowledge of risk assessment was well established by the end of the period of data collection in February 1997. Without doubt, some of the raising of awareness was a result of the Hawthorne effect of the author asking questions about risk assessment, particularly when dealing with managers and engineers. Another effect was a direct result of the new commercial imperatives introduced by changes in the external context. The changing of the MIV bearings, without de-watering the station, is recorded in detail as a case study in risk management in Appendix A and is discussed in Chapter 8, section 8.4.7. This was the first time in the world that such a procedure had been attempted and was a considerable technical achievement. The potential risks were extremely severe but the approach adopted was to assess the risks involved in each stage of the operation and to adopt a rigorous procedure to control the risks. A powerful driver in developing this technique was the commercial need to avoid a station outage, for reasons fully described in Appendix A. This development sits alongside the development of PSB as a business in the new environment, described in Chapter 4 and Glendon et al., (1994 and 1997). In many ways the senior management team saw the business in terms of the managing of

commercial risk and the MIV bearing project provided a powerful illustration of the interdependence of the safety and commercial risks. This project seemed to mark a turning point in the appreciation of the role of formal risk assessment. Another other major engineering achievement was the sealing of the penstock leak, again without de-watering the station, which is described in detail as a second case study in Appendix B and is discussed in Chapter 11, section 11.4.11. Again the approach was to produce a meticulous technical procedure but as pointed out in Appendices A and B, the risk assessment was purely technical and did not involve any human reliability component. This is not to belittle the progress that had been made in PSB in relation to an understanding of the significance of formal risk assessment but it serves to support the contention that safety was still primarily a technical issue. (For detailed comment on the developing approach to risk assessment, reference should be made to Chapter 8 and 11 and Appendices A and B.)

A further development of great significance to risk assessment was the fact that the sale of First Hydro to Mission Energy was partly financed by the sale of 25 year 9% Bonds, which meant that the Company had an absolute financial obligation which extended beyond the original design life of some of the assets. This resulted in a complete assessment of the plant with a view to ensuring future earning capacity, a further important element in the integration of risk assessment into the thinking of senior staff in the Company.

By the end of the research period, the principles and the importance of risk assessment was well established and well known. Although many basic procedures were still not available, real progress was being made in this area, with the newly appointed safety advisor facilitating the process. Most of the change in outlook had been the result of the changing outer context.

12.13 The Questionnaire

The development and use of the questionnaire used in this research, is described in detail in Chapter 9. The questionnaire was based on the safety culture prompt list in the third ACSNI Report, Organising for Safety. The prompt list essentially comprises a list of indicators of positive safety performance, based on the ACSNI HFSG's review of the research in the field. The purpose of the questionnaire and indeed of the research, was to

attempt to assess the evolution of the safety culture of part of the ESI against the factors deemed by ACSNI to be significant, in the context of the changing forces and influences which were moulding the culture. The questionnaire was specifically intended to meet the following objectives:

1. To be an instrument to gather data from a larger sample of the population than could be achieved by discussion and interview
2. To gather data in a more objective way than by discussion and interview
3. To test the validity of the data obtained by other means
4. To assess the status of PSB in relation to the factors in the ACSNI prompt-list
5. To assess the usefulness of the ACSNI prompt-list

Knowledge obtained during initial data collection was useful in the development of the questionnaire, which was first issued, after a validation process, in March 1995. A second issue was made in February 1997, some two years later. Information obtained from the questionnaires is noted in Chapters 9 and 10 and elsewhere in this Chapter. Statistical information from the questionnaires is recorded in Appendix F.

The questionnaires proved extremely useful in achieving objectives 1, 2 and 3 above. It may be observed that the other means by which information was obtained were very demanding in terms of time and resources. In respect of objective 1, the questionnaire provided data from a greater number of staff than could be interviewed even though the total population was small and the response to the second questionnaire was significantly lower than the response to the first. It may also be noted that the use of a questionnaire provided every employee the opportunity to contribute to the research. The research therefore demonstrated the usefulness of the questionnaire as a means of obtaining data cost effectively and quickly.

Objective 2 was to gather data in a more objective way than by direct observation and interview. In fact the questionnaire responses produced no significant surprises and confirmed the judgements formed from informal discussion, structured interviews and direct observation. In this sense the questionnaire served to validate the data already obtained and to support and validate the judgements made by direct observation, thereby meeting objectives 2 and 3.

The body of data obtained from the questionnaire enabled the status of PSB to be established very clearly in respect of most of the factors in the ACSNI prompt-list, thereby satisfying objective 4. It is interesting to note that at a time when the questionnaire was indicating a relatively low level of trust in management generally, the factors related to safety and welfare indicated very high levels of trust and confidence. This seems to indicate that the values and beliefs relating to safety had survived largely unscathed, the trauma of the privatisation process.

The further analysis of the data using the ANOVA programme identified some differences in attitudes discussed in Chapter 9 but the most interesting aspect was the significant difference in outlook between the supervisors and the supervised. In general terms the supervisors had a more sanguine view of the situation than the supervised. This was as might be expected but it does at least provide management with evidence that there may be a significant mismatch between their view and that of the bulk of the workforce.

One of the limiting factors in the use of the questionnaire was the small population size. The proportion of responses from the first issue was reasonable at 45%, although in terms of absolute numbers at 88, any further analysis was marginal. Nevertheless the results were subjected to factor analysis and five factors were identified which are discussed below.

The second issue of the questionnaire produced a much lower response of 31% and 69 in total numbers. This did not provide a basis for any further meaningful factor analysis. The analysis of the responses indicated the same broad picture but when the responses were inspected in terms of supervisors and supervised, it emerged that there had been a general shift towards a more positive view on the part of the supervisors and towards a more negative view on the part of the supervised. The possible reasons for this have been discussed in 12.9 above.

Although limited by the sample size and the level of response, it may therefore be claimed that objectives 4 and 5 above were met. The questionnaire was subsequently used, with some modification, as a basis for an assessment of the safety culture of another electricity utility. A particularly useful and practical outcome was the very clear

identification of generally held views in relation to aspects of the organisation's culture, which indicated areas which management may consider satisfactory as well as areas which may require management attention.

The five factors identified by factor analysis were referred to in Chapter 9 and are reproduced again in Table 12.1 below:

Table 12.1: Factors Identified by Factor Analysis

Factor 1 Partnership	Factor 2 Safety Rules	Factor 3 Safety Arrangements	Factor 4 Safety Violations	Factor 5 Safety Supervision
Staff involvement Trust Communication Participation	Application Enforcement Practicability Conformity	Knowledge/skill Training Practicability Equipment provision	Supervisory attitude Safety vs productivity	Instruction Inspections Monitoring Praise

Tables in Appendix F show the correlations between individual questions and each of the five factors as well as the mean scores relating to the responses to each question. In all, the five factors encompass 26 of the 51 questions in the questionnaire. Each factor is briefly considered in turn below:

- **Factor 1 – Partnership** - This factor embraces the issues of management/staff trust, the degree to which staff believed there was effective staff participation and the perception of staff of the effectiveness of policy communication. It has been conveniently summarised in the concept of *Partnership*. The mean scores in these areas were relatively low although, as has been indicated, they were significantly higher than for the rest of NGC. The reasons for both the low absolute scores for PSB and the relatively higher scores than NGC, have been discussed in 12.4 and 12.5 and elsewhere in this thesis.
- **Factor 2 – Safety Rules** – This factor encompasses the rigorous application and enforcement of the Rules and the belief that they are practicable and that staff conform to them. The mean scores were high in relation to this factor which is perhaps, an expression of the continuing strength of the CEEB safety culture as portrayed in Figure 11 and described in Chapter 8.

- **Factor 3 – Safety Arrangements** – This factor includes issues relating to staff perceptions of the adequacy of the safety arrangements relating to their training, their own knowledge and skill and the adequacy of the general arrangements and provision for their safety. The mean scores were high, indicating a general high level of satisfaction, including self-satisfaction. This again accords with the safety cultural values displayed in Figure 11 and it is interesting to note that any dissatisfaction with other issues does not appear to have had any marked influence on staff views in this area. It is worth noting here that in spite of the high mean scores in this area, there were deficiencies in staff training, skills and knowledge. This may indicate a weakness in the ACSNI definition of safety culture which refers to “...confidence in the efficacy of preventive measures.” It is suggested that this definition would be improved if it referred to “...*a well-founded* confidence in the efficacy of preventive measures.”
- **Factor 4 – Safety Violations** – This factor relates to attitudes to safety, particularly on the part of supervisors and the extent to which safety competes with production pressures. The mean scores were very low which is indicative of the general belief that safety is important and is not sacrificed to production. Once again this emphasises the strongly held cultural belief in the importance of safety illustrated in Figure 11 as being an enduring CEGB value.
- **Factor 5 – Safety Supervision** - This factor embraces staff perceptions in the effectiveness of the supervision provided by the supervisors in relation to their instructions, checks and inspections and the giving of praise. Mean scores here were not low but were not particularly high indicating that in fact performance in relation to general supervision was not exceptionally good. This too reflects the dichotomy between high levels of performance on technical safety and a significantly weaker performance on general safety issues. Once more this represents a strand of the CEGB cultural values indicated in Figure 11, carried through into PSB.

12.14 Changing Safety Culture

This thesis has examined the nature of the CEGB organisation and its organisational and safety culture, as the starting point for an understanding of the subsequent evolutionary process. The technocratic values and attitudes dominating the original engineering driven organisation have been described and shown to be deeply entrenched and

resistant to change. The fact that the managers and staff involved throughout this process were long serving ESI career employees, has been shown to be significant.

The forces from the outer context presented new drivers of profit, share price, market forces and peer pressure from other companies. All of this resulted in new expectations, demands, priorities and targets. The changed environment altered the *raison d'être* of the organisation, which now had to engage in new and unfamiliar business activities. The effect of these changes was crucial, not only in establishing the form of the new structure of the industry but also in providing the Directors of NGC with different objectives and priorities and causing them to introduce changes in internal organisational structures and to attempt to encourage different behaviours. In NGC this led to downsizing and the creation of internal markets and also to attempts to introduce cultural change. The manner in which these factors impacted on PSB and its parent body NGC, have been described, in relation to the staff in general and in relation to the changes in internal arrangements and policy structures. Some of the problems and difficulties arising from the process of change have been identified and the relative failure to achieve change in cultural values by exhortation and the relative success of achieving behavioural change by structural changes, has been confirmed.

Wheatley & Parker, (1996) point out that attempts to change culture through Corporate Visions and Mission Statements are not likely to succeed and Toft, (1992) argues that change by edict has only a limited chance of success. This research has provided evidence in support of that view. According to Waring, (1996), one of the features of a functionalist world view is a failure to recognise the distinction between the values and change strategies proclaimed by management and the enacted values in the organisation. This leads to the view that culture change can be achieved relatively quickly by decree or prescription. Professionals, including engineers who are used to quantifying problems are particularly prone to a functionalist view (Mangham, 1979). It has been seen that major reorganisation which may involve people feeling threatened, can sit uneasily with high sounding intentions about enhancement of individual roles. This can result in incongruence between the values of staff and the values they believe the organisation is promoting.

Those areas where change was seen to succeed were where there was a specific driver which could not be ignored. In the case of NGC, the changing of internal relationships between the Corporate centre and the businesses into a customer/client relationship, underpinned by an internal market and service level agreements, did help to reinforce the message that the role of the centre was to provide advice, not direction. This also led to a participative mechanism for formulating policy. The driver in this case is the fact that reorganisation and a changed relationship is real and is not going to go away. People have to accommodate to the new situation. In the case of PSB the driver was the commercial reality of having to compete in the newly created market for electricity as well as the need to secure contracts. They adapted well to the new situation and it has been shown that the new commercial drivers resulted in innovative engineering solutions and the integration of risk assessment into their thinking.

Evidence that cultural values are deeply held was provided by the cognitive dissonance experienced by shift engineers in PSB, who were uncomfortable with the fact that they now believed that their job was to make money not electricity. Something valuable to them had been replaced by something else in which they could not feel the same pride.

It was evident that the technocentric attitudes which characterised the culture of the CEGB had largely survived the changes. In many respects the safety culture of First Hydro remains that of the CEGB. All the First Hydro Executive Directors are long serving CEGB employees and all of them except the Managing Director, are engineers. PSB has retained the best aspects of the CEGB technical standards of excellence and innovation and has successfully married them to the commercial environment in which it now operates. Although the staff have been through a long and corrosive period of uncertainty they have been insulated by the factors set out in 12.9, from much of the difficulties experienced elsewhere. The fact is, that for many of the staff, little has changed. The fact that the safety culture has survived all these changes is an indication of the deep seated nature of the beliefs and values sustaining it. Many of the sources quoted in this thesis refer to the difficulty of changing deeply held values. This can be a source of strength to an organisation, if values that are soundly based are under threat.

The actual safety performance of PSB, in terms of accident rates, improved during the research period and the annual rolling average accident frequency rate was zero at the

time of the second issue of the questionnaire. The important positive aspect of the change in safety culture, the acceptance of the crucial role of the risk based approach, has been referred to above. At the same time it must be recognised that both NGC and PSB inherited a serious weakness in the CEGB safety culture, the low level of appreciation of behavioural aspects of safety. This weakness persists and is again a feature of the functionalist approach.

The final stage in the evolution was the purchase of First Hydro by Mission Energy who see First Hydro as a stand-alone company and do not interfere in day to day management. Although the protection afforded in the past by being part of a much larger organisation is gone, the Company is now the master of its own fate and can order its priorities in accordance with its own needs, in a way which has previously been impossible.

12.14 Summary of Conclusions

The preceding discussion has identified a number of conclusions which can be drawn from this research, in relation to the organisation which is now First Hydro, a Mission Energy Company. The conclusions are summarised below:

1. The original technocratic CEGB safety culture has largely survived and is sound but the main limitation of the CEGB safety culture, the low level of appreciation of the human behavioural aspects of safety, has also survived.
2. The safety culture has been appreciably strengthened by a significant raising of awareness of the crucial role of formal risk assessment and an appreciation of the essential link between commercial and safety risk.
3. The heightened appreciation of risk assessment has largely arisen from the new commercial imperatives facing the organisation.
4. In relation to non-operational safety, the standards that have existed for many years have established a norm, which is accepted by many of the staff, whose attitudes are trapped within existing standards so that management attempts to raise standards are repeatedly frustrated.
5. Management are sincere in their commitment to achieving high standards of safety and in allocating sufficient resources but have so far been unable to achieve the necessary modification to attitudes and behaviour, because they too have been limited by an inadequate appreciation of the behavioural aspects of safety.

6. The organisation has been protected from many of the more negative aspects of change in NGC, by a powerful combination of insulating factors.
7. The prolonged period of uncertainty surrounding flotation and sale had a damaging effect on those cultural issues involving trust in management.
8. The ACSNI prompt-list based questionnaire proved useful in providing objective confirmation of the data obtained by other means and in assessing the status of the organisation in relation to the ACSNI factors.
9. The questionnaire would be a useful tool for identifying areas of weakness requiring management attention.
10. The questionnaire responses revealed significant differences in perception between supervisors and the supervised, which had generally increased by the time of second issue of the questionnaire. (A possible explanation for the differences has been suggested in this Chapter.)
11. The evidence from the various analyses of the questionnaire responses supported the accuracy of the analysis of the safety culture derived from observation and interview and was consistent with the historical analysis of CEGB culture.
12. The researcher's activities as a participant/observer/expert, resulted in a Hawthorne effect which, to a limited extent, altered the course of events.

12.15 Further Work

The essential purpose of this research was to study an organisation in transition under the influence of changes in the external context. It was noted by Heraclitus c500 BC that "Nothing is permanent but change" (quoted at the start of Chapter 11), and it is certain that change is no less a feature of modern society. PSB, (now First Hydro), will no doubt continue to adapt and evolve in response to further changes in the external context. Nevertheless, the particular period of dramatic change which saw PSB evolve from a long period of state control and public ownership, through the privatisation process as part of NGC and eventually to be a wholly owned subsidiary of a US utility, is at an end. In this respect the research is complete, although it is axiomatic that more study is still needed in the general area of organisational and safety culture, during organisational change. Finally it may be argued that this research has demonstrated, that the role of the participant / observer / expert, with detailed internal knowledge, is a useful mechanism for providing a distinctive insight into organisational development.

APPENDIX A – MAIN INLET VALVE BEARING CHANGE PROJECT

The technical detail in this Appendix is derived from an assessment of the procedure prepared by NNC Ltd (Bedding, 1994), the PSB risk assessment of the procedure (Moss & Tee, 1994) and interviews with the PSB Mechanical Engineer, Bill Moss.

A. 1 Background

During August and September 1994, the bearings were changed on one of the Main Inlet Valves (MIVs) at Dinorwig, using a novel technique developed within PSB with the involvement of the suppliers of the valve. The technique provided substantial commercial savings to the Business but was technically challenging and involved a meticulous approach to the management of very considerable risks. This technique had never previously been used anywhere in the world and therefore it had commercial potential far beyond the direct benefit to Dinorwig. This Appendix is a case study of the PSB approach to the management of risk during the project.

A.2 General Description of the Hydraulic System.

The water supply to Dinorwig Power Station from the upper reservoir, is illustrated simply in cross-section in Figure 3. From the Upper Reservoir the water enters a low pressure tunnel via the headgates. The low pressure tunnel is 1695m long. The water then enters a vertical shaft at the intersection between the high pressure shaft and the surge shaft. The high pressure shaft is 443m deep and 9.5m diameter. From the bottom of the high pressure shaft the water enters the high pressure tunnel for 446m down a 1:10 gradient before joining the high pressure manifold system which feeds six steel lined high pressure pipes (penstocks) 170m long, which reduce in diameter from 3.3m to 2.5m when they meet the Main Inlet Valves.

Each of the 6 MIVs supplies one of the six turbines through which the water passes before exiting to the lower reservoir via the draft tubes, draft tube valves, tail race tunnels and tail works.

For all normal operation and maintenance, the MIVs are the point of isolation for the water supply into the power station. It is possible to isolate the system at the top reservoir by closing the headgates although these take some 30 minutes to close. If it is necessary to drain the power station, the headgates would of course have to be closed but the de-watering of the high-pressure shaft has to be done very slowly to avoid damage to the shaft by water pressure imploding the concrete lining and takes several days. During this time the whole station is out of action since it is dependent on a single supply tunnel. De-watering the station is therefore a very drastic step, involving loss of revenue of several million pounds on each occasion and is therefore only considered when it is unavoidable. Therefore the Station is completely dependent on each of the MIVs to provide isolation from the high-pressure water supply for all normal purposes.

A.3 The Main Inlet Valve

The Main Inlet Valves are massive rotary valves designed and manufactured by Kvaerner Boving with a diameter of 2.5 m and a design operating pressure of 80 bar. They are capable of opening in 5 seconds and closing against maximum flow in 20 seconds. The design of the MIV is illustrated in Figure 12.

Within the casing the valve itself is effectively a sphere with a hole through it along the axis of the inlet pipe. With the valve open, the hole is longitudinal to the direction of flow and therefore allows water to flow. When the valve is turned through 90 degrees it presents a spherical closure thereby preventing flow. The rotary valve is supported and turns upon two trunnion bearings, one at each side of the valve. The valve is closed by



Figure 12: Diagram of Main Inlet Valve at Dinorwig

the effect of gravity acting upon the two 16 tonne counterweights attached to the trunnions. The valve is opened by twin oil pressure-operated hydraulic cylinders with hydraulic rams which operate on the lever arms attached to the trunnions. A seal is capable of being applied at each side of the MIV when it is in the closed position. The seal at the downstream side is known as the service seal and the seal at the upstream side, the maintenance seal. When the valve is closed in the normal operational mode, the ball is first rotated to the closed position and then the service seal is applied. This consists of a stainless steel annular ring which is forced by water pressure onto a machined ring on the valve body, forming a metal to metal contact and effectively preventing the passage of water. The water pressure to operate the seals is taken from the high pressure side of the valve. The maintenance seal operates similarly on the upstream side and is applied whenever access is required downstream of the valve or when work is to be done on the valve itself. The maintenance seal is therefore used whenever the valve is used for isolation purposes.

The bearings within which the rotor trunnions move are self-lubricating, 781 mm inside diameter and 400 mm long and manufactured from Lubrite Bronze. A stainless steel liner 10 mm thick is shrunk onto the rotor trunnion. Any work on the bearings of the MIVs is absolutely dependent on the MIV and the maintenance seal.

Since correct functioning of the MIV is wholly dependant on the bearings, the removal of the MIV bearings themselves could only be contemplated if the station were to be dewatered and isolated from the upper reservoir at the headgates. It should be noted that there is a dismantling joint downstream of the MIV that can be removed to give access to the service seal assembly. If the valve is to be isolated for any length of time a pressure dome is fitted on the downstream side of the MIV in place of the dismantling joint.

A.4 Operational Experience

During previous maintenance work it had been observed that the dowels retaining the trunnion liners had sheared, allowing the liners to move outwards to the extent that some were retained by the counterweight levers. This would expose the inner and most highly loaded part of the bearings to turbulent water flow with possible loss of lubricant. The problem was temporarily overcome by jacking back the liners, adding more dowels and inserting loose retaining cylinders.

After 10 years of operation it was considered that the bearings and the liners were worn to the extent that replacement was probably necessary. The gland seals were no longer coping adequately and were having to be replaced at two-yearly intervals rather than the five years typical in the early years of the life of the station. The original design life of the bearings was 400 000 cycles in a period of 55 years and therefore no provision was made for changing the bearings during normal maintenance. In the event, the wear had been greater than anticipated and the decision was made to remove the bearings on all MIVs for inspection and replacement, as necessary, over the next 3 to 4 years.

The standard procedure for removal of the MIV bearings would require de-watering of the station, the "dry method". The length of time necessary to complete de-watering, carry out the work and re water would be over 4 weeks with a consequent considerable loss of revenue. A proposal for a bearing replacement programme was put forward in the early 1990s but because of the costs of a complete station shutdown an alternative proposal was explored which would allow bearings to be replaced with the station operational, the "wet method".

A.5 The Proposed "Wet Method" of MIV Bearing Removal

With the MIV closed, it is holding back a head of water of more than 500 m with the pressure on the upstream side of some 62 bar and some 7 bar on the downstream face.

In this condition the trunnion liner is clearly pushed with very considerable force against the bearing, making it quite impossible to move the bearing.

A working party was established with the valve designers to investigate a long term solution to the problem and in 1988 an idea was suggested which would allow bearing replacement without de-watering. In 1990 a design study was commissioned to determine the feasibility of the proposed technique. In 1993 the proposal was tested to the point that the bearing was moved a few mm but no attempt was made to remove it. Hence it was proposed to undertake the first full bearing removal and replacement during the planned outage on Unit 2 in August 1994.

A.6 The Procedure

The basic concept is to remove the service seal assembly and insert a support plate which bears onto the service seal seat of the downstream face of the MIV rotor. (See Figure 13.)

The support plate is supported inside the isolating dome which is provided for long term unit isolation and secured by Rotabolts. The void between the isolating dome and the support plate is then hydraulically pressurised which forces the support ring to push the valve rotor upstream against the pressure of the head of water. Centralisation of the trunnion bearing is then achieved with the clearances at gaps 1 and 2, being measured between the MIV body and the dome (fig A.5). The dome is pressurised and appropriate shims are inserted into the gaps 1 and 2. The dome is then de-pressurised and the Rotabolts are tensioned until the studs load is equivalent to 78 bar, thus locking in any deflections in the whole assembly.

The dome is now de-pressurised leaving the whole system securely fastened together with the dome still in place. This leaves the MIV rotor central in its bearings but held mechanically in this position, against the upstream pressure. Once in this position, the



Figure 13: MIV Bearing Replacement Layout

trunnion seal assembly can be removed, giving access to the bearing and liner. The bearings on each side can then be removed and if necessary, the liners can also be replaced. If there is a delay in replacing either the bearing or the liner, a trunnion safety cover can be fitted to the bearing orifice. As far as was known, this approach to removing an MIV bearing had never previously been attempted anywhere in the world and involves the control of major risks.

A.7 The Hazards Associated With the Procedure

The two main hazards are the presence of high-pressure water at the face of the rotor and the handling of heavy equipment in a very restricted space. The support ring and the dome each weigh more than 10 tonnes. The potential consequences of the water hazard range from the worst possible scenario of an uncontrollable flood to relatively minor leakage that could nevertheless be a hazard to personnel. The hazards associated with handling heavy equipment are no different to those encountered in normal maintenance operations.

An additional risk with a novel procedure is that a stage may be reached in which it is not possible to continue the work or to restore the MIV to its original state. In this event the trunnion covers would be fitted and the MIV and associated unit would have to be left out of service until the problem could be rectified. In the worst case this could mean that the unit would remain out of service until the station could be de-watered probably in the summer of 1996. The estimated cost to the business of such a prolonged outage was of the order of £17.5M but the alternative was to undertake the bearing change by the "Dry method" which had been estimated to cost some £6M more per unit than the "Wet method". The probability of requiring such an outage was assessed as <1% and therefore the risk of using the "wet method" was justified.

A.8 The Approach to the Work

A.8.1 The Development Team

The PSB Head of Mechanical Engineering led the team who developed the wet method. The team included the Principal Design Engineer from the MIV manufacturers and also a SPE taken off shift and seconded to the project. The SPE was responsible for safety issues and personnel. The team also included fitters with wide experience. The team therefore comprised all the elements capable of contributing to the final method and indeed the same team was used in the initial trial of the method in 1993 and the actual completion of the work in 1994. All team members were encouraged to contribute and were personally involved in the development of the procedure. During the 1993 trial and again during 1994, the team worked long hours dedicated to this single task, remaining underground almost all of the time during each working day. During 1993 the Head of Mechanical Engineering adopted the strategy of determining the task for each day and the team then worked until the task was achieved. The team spirit and motivation were maintained at very high levels.

A.8.2 Design Studies

In the early stages of development, a consultancy contract was placed with Kvaerner Boving to explore the possibility of a "wet method" of bearing replacement. This early work, together with an appreciation of the commercial potential, led to a further contract in which Kvaerner Boving produced a photo-elastic computer model of the MIV and detailed finite-element analysis (FEA), using 54k nodes. This work confirmed the suitability of the concept of the dome and support plate, as well as analysing in great detail the stress levels within the MIV casing and in other components. Strain gauges were attached to the MIV body to verify this analysis before conducting the replacement exercise, since the FEA modelling was used to assist the design of the bearing replacement method. Fifty two gauges were attached and monitored over a week confirming the theoretical analysis. The intention during the actual removal work would be to fit strain gauges to the assembly to monitor the

readings during the operation. If variations between measured and predicted levels were found and were higher than expected, the work would be halted until an explanation could be obtained.

A.8.3 Pressure Testing

The dome and support ring were subjected to over-pressure tests at the manufacturers to ensure adequate performance of the components and seals.

A.8.4 Method Statement

From the design studies a method statement was prepared which was used during the 1993 trial, modified in the light of that experience and adopted during the completion of the work in 1994.

A.9 Risk Assessment

PSB produced a document identifying the various stages of risk assessment in the approach to the procedure which analysed the project in relation to three aspects in turn:

1. Risk of Water Release
2. Risk of Injury to Personnel
3. Risk of MIV Out of Action Indefinitely or Delayed Return

In each case the risk was first analysed and then the counter measures proposed to control the risk were set out.

A.9.1 Risk of Water Release

A.9.1.1 Failure of the MIV Body or the Pressure Dome

The computer design studies, FEA, empirical checks using strain gauges and pressure testing, together with the use of strain gauges during the work to confirm that the actual stresses were as calculated, were the means adopted to control the risks of failure of the MIV Body or Pressure Dome.

A.9.1.2 Maintenance Seal Failure While MIV is Breached

During most of the procedure the MIV body is completely sealed either by the normal trunnion seal and dome or by the trunnion cover and dome. There are two stages in the procedure when this is not the case. The first is during the removal of the service seal and the fitting of the pressure dome and the second is during the actual removal and replacement of the bearing. Three possible reasons were identified which could cause a failure in the maintenance seal. These are dealt with in turn below:

A.9.1.3 Rotor Not Square

When the service seal is removed and replaced by the support plate this will bear upon the rotor under hydraulic pressure, forcing the rotor upstream against the head of water. If the rotor is not square with the penstock axis the transferred load on the rotor will be uneven and could lead to misalignment an interference with the integrity of the maintenance seal. To counter this eventuality, the rotor position would be checked and marked permanently, prior to replacement and monitored throughout the process. There are six jacking screws at various positions in the MIV casing which can be used if necessary to correct the alignment of the rotor. In addition, the maintenance seal leakage rate would be continuously monitored and the uniformity of the load applied by the support plate will be monitored by strain gauges and the work halted if readings were unacceptable.

A.9.1.4 Tripping Of Five Machines

The simultaneous tripping of the remaining five units will cause a major fluctuation in penstock pressure which could cause interference with the maintenance seal or even cause debris to be trapped in the seal. A design study was commissioned which concluded that there was "virtually no way that debris could get trapped in the seal". Even if it did, the leakage would be well within the capacity of the station emergency pumps.

During commissioning, a test demonstrated that the maintenance seals withstood the effect of a simultaneous three machine trip without leakage. During the work the station was to be restricted to three other units in service, whilst isolation is dependent only on the maintenance seal and personnel are in the MIV gallery. If more machines were in use, the MIV gallery was to be evacuated.

If a pressure swing occurred when the support ring and dome were in position, the M 90 Rotabolts would be tensioned to an equivalent pressure greater than the tripping pressure which will prevent leakage at the maintenance seal. The bolt tension is crucial which is why Rotabolts were to be used which are pre-set to two values; the required load and the maximum load. They are capable of simple monitoring throughout the process. Great care would be taken in testing and confirming the correct calibration of the Rotabolts.

A.9.1.5 Distortion of MIV Body

The F E analysis confirmed that the distortion of the MIV body due to the pressure during the process would be insufficient to cause interference with the maintenance seal.

A.9.1.6 Risk Of Injury to Personnel

The risks to personnel were from water leakage through the trunnion orifice which could cause them to be knocked off the scaffold. The precautions already identified were designed to ensure the integrity of the maintenance seal isolation and that any water passing into the MIV body would be drained away with the rate of flow and the level continuously monitored. The remaining significant hazards to personnel were concerned with materials handling. The large components were designed or modified so that they could be handled easily, the Rotabolt heads were modified for easier handling and installation and scaffolding was arranged for easy access with adequate lighting.

A purpose built rigid platform was designed for erection adjacent to the trunnion orifice so that the bearing could be withdrawn directly onto a cradle and so that the liner could be machined in site as necessary. The platform was bolted to the floor and provide good and safe access within the working area. Prior to the replacement of the bearings, Seminars were provided for all staff concerned as well as for other groups of PSB staff and contractors.

A.9.2 Risk of MIV Out of Action Indefinitely or Delayed Return.

Three factors were identified which could cause the MIV to be unable to be returned to service. These are dealt with in turn below:

A.9.2.1 Misalignment of the Maintenance Seal

Although the misalignment of the Maintenance Seal should be extremely unlikely, in view of the measures to be taken, it was possible that the problem could be overcome by opening and closing the seal several times. If however the seal remained jammed or misaligned, the MIV and unit would have to remain out of service until the station could be de-watered.

A.9.2.2 Lodging of the Bearing or Liner.

The bearing and if necessary the liner, were to be withdrawn onto a purpose built cradle on the specially designed platform. Pressure gauges were to be used to ensure an even pull during withdrawal. The risk of the bearing or liner lodging was therefore very low and if this were to happen, the trunnion covers could be applied with any protruding bearing or liner first being sawn off. The unit would be unavailable until the bearing or liner could be removed with specialist tools. To reduce the risk of this eventuality the entire rig was tested in a full size mock up at a specialist firm and all operations and machining activities were demonstrated to be feasible.

A.9.2.3 Wedging of the Jacking Screws

In order to reduce the possibility of a pressure surge causing the rotor to join on the downstream jacking bolts, these were fitted with soft collapsible noses.

A.9.3 External Validation of the Risk Assessment

The proposed system was assessed externally by NNC in detail. This external assessment confirmed that the procedure was satisfactory.

APPENDIX B - PLUGGING THE PENSTOCK LEAK

The technical detail in this Appendix is derived from the First Hydro Safety Plan for Grouting the Penstock Leak (First Hydro, 1994), and interviews with the First Hydro Civil Engineer, Owen Williams.

B.1 Background

A major long-term problem for First Hydro was a leak of water from the penstock into the MIV gallery. The leak was first identified in 1987 during routine monitoring of flows into the caverns. In 1988 it was demonstrated that the leak emanated from a pvc drain which had been installed during construction and which had been left in position at the end of construction and had been inadequately grouted. Since the leak was first identified, leakage rates had increased at varying rates but it had always increased. By 1994 the leakage rate was of the order of 200 litres/minute. (N.B. Capacity of emergency pumps - 1600 litres/second). Although the rate of leakage was well below levels which would give rise to alarm, it was unpredictable and was increasing and in the interests of the long term life of the station it could not be allowed to continue. By 1994 it was decided to attempt to seal the leak. This Appendix therefore comprises a case study of the approach of PSB management to the problem and specifically to the control of risk.

B.2 Initial Investigations

In 1990 a remotely operated vehicle (ROV), a submersible device, was lowered into the HP shaft during a station outage and released dye which was videoed being drawn into a concrete/concrete construction joint 6m upstream of the steel penstock lining. This joint was 110m from the MIV gallery. Between 1990 and 1994 several methods of sealing the leak had been considered but none had been implemented. In late 1994, a meeting was held to consider the situation, review the proposals for sealing the leak and to agree the preferred proposal and an implementation programme. Parties represented at the meeting included the PSB Engineering Manager and the Civil Engineer, the NGC Civil Engineer, representatives from a firm of consulting engineers and an academic consultant from the department of Civil Engineering at Newcastle University.

B.3 Conclusions of the Review Meeting

It was agreed that the fluctuations in flow were consistent with partial sealing and re-blocking of the leakage path, where the blockages were unable to survive and develop and were eroded away, allowing the rising trend of flow to resume. It was calculated that with 60 bar pressure in the penstock, the **unrestricted** flow from the pvc drain would be 138 litres/second or 8250 litres/ minute.

The various methods of sealing the leak which were considered were:

- *Self Sealing* - It was considered that conditions were unsuitable for self sealing to be successful and in any event, the location and effectiveness of such a seal would not be known. This was dismissed.
- *Assisted Self Sealing* - This could be achieved by progressively reducing the flow rate to assist the deposition of calcite in the leak. This was also dismissed for the same reasons as unassisted sealing.
- *Grout from de-watered high pressure tunnels* - This would involve prolonged station outage and de-watering in order to drill and grout from inside the tunnel. It was agreed that the probability of plugging the leak successfully would be high but there was a risk of damaging the HP linings and the project costs, as well as business costs would be prohibitive. This approach was dismissed.
- *Grout from flooded HP tunnels with no flow* - This would be done from an ROV and the difficulties and costs would be great and the probability of success not high. This approach was dismissed.
- *Grout from MIV gallery* - This would involve working from the MIV gallery with or without ROV observation. There would be a risk of excess grout emanating into the tunnel and possibly damaging plant as well as a risk of the applied pressure fracturing the pvc pipe and causing a pressure rise in the surrounding concrete. (This could be countered by drilling cored drain holes into the mass concrete to relieve any excess pressure.) The advantages were that the applied pressure and flow rate of grout could be controlled and detailed monitoring maintained. Success probability was assessed as high and costs relatively modest. This approach was accepted for detailed development and assessment.
- *Flow control and/or diversion* - This was the “do nothing” option. It was agreed that the flow could be diverted to the surface at some considerable cost. It was agreed that

this approach would be a contingency for consideration if the selected option proved unsuccessful.

B.4 Development of the Procedure

It was decided that the grouting from the MIV gallery would take place in three stages:

1. Drill cored drain holes into the concrete penstock surround:
 - a - to check for fissures and cracks
 - b - to provide pressure relief for any leakage from the pvc drain pipe during grouting
 - c - to intercept pressure and flow which may otherwise reach surrounding rock
2. Install high quality pipe-work and valves at the gallery face for connection of grouting equipment. All to be anchored by rock bolts.
3. Following appraisal of contractors' method statements, plant and grouting materials, the contractor would connect, test and grout the drain pipe at a pressure above the penstock pressure.

B.5 Hazards

Severn principal hazards were identified:

1. A grouting pressure of >60 bar will be generated at the MIV gallery face and may escape to fissures or joints in the concrete and rock surrounding the penstock, causing:
 - high thrust loads on and movement of the concrete
 - high thrust loads transferred to and movement of the rock surrounding the penstock at the cavern wall
 - high flows from the surrounding concrete to the rock and cavern
2. The grouting pressure of >60 bar may escape to the penstock surround with the consequences described above.
3. The components of the pressure grouting pipe-work may fail.
4. The grout may reach operating plant and cause damage or impede operation.
5. All the preparation and grouting will present a consequential hazard to the workers in the area.
6. The public MIV viewing platform is within the hazard zone.
7. Inadvertent operation of station plant during the procedure could cause a hazard.

B.6 Risk Assessment

A risk assessment was undertaken by the PSB Civil Engineer based on NGC - National Safety Code of Practice GS-MP9. This provides for a hazard rating number (HRN) to be calculated by multiplying factors indicative of the probability of exposure (PE), the frequency of exposure (FE), the maximum probable loss (MPL) and the number of persons at risk (NP):

$$\text{HRN} = \text{PE} \times \text{FE} \times \text{MPL} \times \text{NP}$$

Each of the hazards was considered in turn together with the appropriate control measures and means of monitoring those measures. In each case HRN was calculated for the unmitigated risk and for the risk with control measures in place.

B.6.1 HP System at 60 bar

It was assumed that this situation could lead to a range of consequences from a modest increase in leakage to a catastrophic collapse of concrete and rock into the MIV gallery. The hazard would commence as soon as the anchored pipe-work was used to reduce the flow rate and would be most severe with the flow reduced to zero.

Exposure to this hazard would occur only whilst the pipe-work system was being used to reduce the flow in preparation to grouting. The probability that loss would result was unknown. There were no precedents. A loss confined to additional leakage of up to 1200 litres/second (75% emergency pump capacity), would be manageable but leakage in excess of this would be impossible to manage. The worst case scenario would be failure of the concrete/rock surrounding the penstock and would be unacceptable.

The control measures to mitigate this hazard were:

- a) To provide cored boreholes in the concrete surround to the penstock to:
 1. indicate joints or cracks in the concrete
 2. drain any leakage into the concrete
 3. intercept any leakage before reaching the rock
- b) To build pressure in slow, phased stages with dwell intervals to monitor leakage, cracks and movement.

With these measures in place the HRN was judged acceptable.

B.6.2 Grouting Pressures at >60 bar

The consequences of this hazard are as B.6.1 but potentially more severe. A catastrophic collapse into the MIV gallery could result. The hazard would be present as soon as the grout pumps are used to raise pressure above 60 bar and reverse flow in the drain to inject grout and displace water. The hazard would last as long as grouting continued. The probability that the hazard would result in loss was not known. There were no precedents and the worst case scenario was unacceptable.

The control measures to mitigate this hazard were:

- a) To utilise the cored drain holes as in B.6.1
- b) By injecting water, not grout, in the first instance to assist in predicting grout flow rates and optimum grout viscosity and injection rate as well as back-flushing the leak to remove build up of loose material which could otherwise cause unpredictable pressure build up
- c) The grout injecting plant to be specified to provide steady pressure with pre-set over-pressure trips
- d) Drainage flows to be monitored during water and grout injection and if excessive, injection will be stopped for review
- e) Injection to be carried out with system hydraulic pressure at its lowest
- f) The grouting plant and operators to be located away from penstock 1
- g) The grouting contractor to be selected with care.

With these measures in place, the HRN was judged acceptable.

B.6.3 Grouting Pipe-work and Connections

This hazard involves the pipe-work and connections to be installed at the penstock face prior to the involvement of the grouting contractor. The hazard will start when the connections are complete and leakage restriction begins and will end when the grouting is complete. The probability of loss is low because of the small sizes of the pipe-work. Failure of components would delay the operation.

The unmitigated HRN was judged to be low but would be reduced by:

- a) Specifying components to appropriate standards
- b) Independent checking of design calculations
- c) Pressure testing of all components

d) Compatibility checking of contractors method statements, plant and materials.
With these measures in place the HRN was judged to be reduced to an acceptable figure.

B.6.4 Grout and Station Plant

This hazard may result in grout damaging or preventing correct operation of station plant, including MIV valve bearings and water seals used for isolation and turbine guide vanes and seals. The hazard will commence as soon as grout has filled the leaking drain and will end when grout injection ceases and surplus grout has dispersed or settled. There can be no risk to persons from this hazard but the maximum possible loss could result from an inability to close the MIV maintenance seal. This would require a station shut down of up to six weeks duration. Other possible damage could result in a Unit outage of up to 60 hours duration.

The unmitigated HRN was judged to be unacceptable commercially but would be reduced by:

- a) Selecting a grout which is as dispersive as possible consistent with the objectives of grouting
- b) Pumping a low flow up penstock 1 for the duration of curing time
- c) Setting a pre-determined limit on the volume of grout to be injected based on the estimated volume of the void to be filled
- d) Checking the chemical and physical properties of the grout for acceptability in relation to mechanical plant.

With these measures in place the HRN was judged to be acceptable.

B.6.5 Workers

In addition to any hazard to personnel from the previous hazards, it was considered that workers could be at risk from water and water spray, falling particles of concrete and rock, proximity to operating plant, restricted access and working space, handling grout and low air circulation.

The unmitigated HRN was judged unacceptable but would be reduced by:

- a) Formal liaison with the contractor
- b) Erecting special access, screening and signs

- c) Restricting access
- d) Use of carefully specified PPE
- e) Careful specification and selection of plant and controlling its use
- f) COSHH procedures
- g) Special ventilation arrangements

It was judged that the HRN was acceptable with these measures in place.

B.6.6 Visitors and Guides

The normal public visit (c50 persons/visit plus guides, totalling c700 persons/day), included viewing from the end of the MIV gallery. These visitors could potentially be exposed to the hazards listed above. The unmitigated HRN was judged unacceptable but would be reduced by:

- a) Delineating the contractors area and denying access
- b) Restricting viewing access during pre-determined stages of the work
- c) Prohibiting visits when pressure was being developed (to be achieved, if possible by undertaking such activity outside visiting hours

With these controls in place the HRN was judged acceptable.

B.6.7 Inadvertent Operations

Hazards from inadvertent operations could arise from operation of station plant as well as by inadvertent operation of the grouting plant during pressure working. The latter hazard presented much the greatest risk of concrete and rock failure.

The unmitigated HRN was unacceptable and would be controlled by:

- a) Isolating all MIVs and associated plant during the operation
- b) Automatic pressure relief on the grouting assembly at the concrete face
- c) Continuous specialist supervision

With these controls in place the HRN was judged acceptable.

B.7 Implementation

The issues considered in the risk assessment and the controls proposed were as set out in b.6 above. The risk assessment was further refined in consultation with station staff and in relation to contractors method statements. A CDM Safety Plan was also developed. The grouting was undertaken successfully in May 1996 with the LP tunnel

drained and the head of water therefore reduced in the HP shaft, so that the penstock pressure was actually reduced to 45 bar. During the grouting, another leak was found but the approach was changed to seal this. During the operation, one of the hoses failed, spraying a worker with grout but he was unharmed.

APPENDIX C - PRELIMINARY DISCUSSION, CONCLUSIONS AND SUGGESTIONS

(Reproduced verbatim as presented to First Hydro management)

C.1 Overall Organisational Issues

The ACSNI Report identifies several issues which are part of an organisation's overall culture and which have a significant bearing on safety culture. These include: effectiveness of communication, understanding and sharing of organisational goals, trust, care and concern, effectiveness of consultation and participation, leadership, praise where praise is due, emphasis on competence, good working conditions and working environment.

C.2 A Caring Organisation?

One of the evident strengths of PSB is the very strong belief amongst staff that management genuinely cares about safety, that PSB is very understanding in times of bereavement and serious illness and that it cares about the welfare of its staff. Several examples of "care and concern" are referred to in this Report but it is important to note that in respect of this and other issues, notwithstanding a general majority feeling, individual employees took a contrary view. Some anonymous comments included on questionnaire returns perhaps reveal blind spots in the organisation. One employee at Bala House expressed a strong feeling that PSB could be uncaring and that business needs could come before personal feelings and priorities to the detriment of health, family well-being and commitment and performance at work. It seems clear that stress levels are high in certain parts of the organisation and no specific action seems to have been taken to identify and deal with this problem.

As far as safety is concerned, there was a widespread intuitive view that privatisation and commercial forces would lead to safety being sacrificed to production or profit although no evidence in support of this view could be produced. Staff were, if anything, expressing the view that management were more concerned than before about safety targets.

C.3 One Business, One Team?

In fostering teamwork and support for common goals, it may be assumed that PSB has an advantage in being a small organisation of less than 200 staff. Against this is the considerable disadvantage that the staff are dispersed between three locations, each separated by significant travelling time. This exacerbates the inevitable tensions that exist within PSB at certain interfaces and contributes to a lack of understanding of the role of colleagues which, in turn, can feed suspicion and resentment.

Although it would be wrong to overemphasise this issue, some tensions were noted between and within locations. Considerable efforts were being made to explain the work of Bala House to the other locations but there remains scope for further effort to achieve better integration and understanding. Within Ffestiniog, the historical divisions were being energetically and effectively addressed by the manager and there was little evidence of the antagonism which apparently once existed.

At Ffestiniog, there was some suspicion and mistrust of Dinorwig and a belief that Ffestiniog was the poor relation. Perceptions of Ffestiniog by staff from other locations seemed to lag behind reality. Whilst Ffestiniog was undoubtedly a conservative unit, attitudes and the organisation seemed to be changing faster than others acknowledged. At both Dinorwig and Ffestiniog, the questionnaire results indicated a lack of faith in the efficient planning of work. Tensions amongst operational staff towards planning had been noted in strong comments at Dinorwig.

It must be acknowledged that other factors were influencing staff perceptions and attitudes during the study and in some cases could work against trusting relationships with management. These factors included dissatisfaction with certain aspects of the Company Agreement and the annual pay award. Adverse reaction to the pay award was linked to Directors' remuneration which clearly offended staff at all levels who volunteered their strong feelings of outrage. No contrary views were expressed.

Another factor was the introduction of STARS, about which there was little enthusiasm and much suspicion. These feelings were common to the assessors and the assessed. International Hydro was seen as taking resources, including scarce manpower, with nothing to show and the use of contractors was seen as threatening by some staff groups. The extensive use of consultants was also an irritant to certain groups.

Most of the staff at Ffestiniog acknowledged that the station was likely to be unmanned in the future but the uncertainty about when this would happen was clearly worrying and provided fertile ground for rumour.

The overriding concern, which grew during the study, was the future of PSB itself, the probability of de-merger and the prospects for PSB after de-merger. This scenario presented more uncertainty than any other issue and was exacerbated by the inability of staff to influence the outcome. Staff were concerned about jobs, pensions and their share-save options.

It is assumed that all the above factors influenced attitudes during the study and would have a particularly negative effect on the level of trust of management. The questionnaire indicated that staff in general did not trust PSB management and the trust was lower at Ffestiniog. In this respect the questionnaire supported the results of the NGC Communication Survey Report, which was issued during the study. This indicated a similarly low level of trust in management, although PSB featured much better than most of NGC. It is interesting to note that the low level of trust in management coexisted with the belief that management genuinely cared about safety and that PSB was understanding in relation to care and concern issues.

Considering the matter of shared goals, it was clear that several members of staff had real difficulty in reconciling the aims and objectives of PSB with their own values. This was particularly true of those, such as shift engineers, whose jobs had been changed significantly by the commercial imperatives of privatisation. They retained a strong sense of pride in producing electricity for the nation but could not find the same pride in making money, which they now saw as being the primary objective. Whilst they were operating professionally within the new regime, they retained a belief that the old regime was morally superior.

Insofar as PSB's specific safety goals were concerned, only 41% of respondents to the questionnaire could correctly identify the AFR safety target of PSB and only 22% could specify the correct current performance.

C.4 Effective Communication?

The questionnaire produced low positive scores for the proposition that *PSB policy is effectively communicated to individuals* and a particularly low positive score for the proposition that *staff are promptly told about changes which affect them*. These results are similar to the PSB results in the NGC Communications Survey.

Many serious attempts at communication were observed during the study via the PSB Newsletter, the Local Council and HESACs and interactive video presentations installed at each location as well as many specific staff briefings. Nevertheless, several examples

of ill-founded rumour were also noted. The residual impression was that management were trying to communicate as fully and as openly as possible but that on issues such as de-merger, the staff always believed that they were not being told everything. It seems almost certain that this fact coloured staff views on the effectiveness and timing of communication and on the low level of trust in management.

C.5 Consultation and Participation?

The questionnaire produced a low positive score for the proposition that *staff are consulted about changes which affect them* and negative scores for *relevant staff get the opportunity to contribute to working procedures before they are implemented* and *contributions from staff are taken into account in final procedures*.

At the same time, the Local Council and the HESAC meetings were dealing in detail with matters of substance and the questionnaire revealed that staff felt they were well informed about the activities of their safety committee. There was a tangible atmosphere of antagonism towards management within Local Council meetings which was completely absent in the HESACs. It is possible that the Local Council atmosphere is a function of its negotiating role but the feeling of antagonism towards PSB management was not encountered during any interview or discussion with individual members of staff.

The HESACs were conveniently used for executive decision making by the managers who chaired them during the study and they seemed to operate pro-actively, effectively and without tension. There is a need to ensure that the Local Council is not used as a *Court of Appeal* for inappropriate and trivial items, for which the responsibility should rest with the location managers.

A good example of genuine participation and involvement was the creation of a focused, multi-disciplined team for the MIV bearing replacement project.

Staff safety representatives were observed to be playing a positive and valuable role and were both supportive of management's safety objectives and occasionally promoted initiatives themselves.

C.6 Leadership, Management and Supervision

The PSB style of management observed during the study was open, tolerant and certainly not autocratic. Several examples were noted of considerable efforts to communicate the maximum amount of information to staff, consistent with commercial

confidentiality and particularly the confidentiality arrangements surrounding the issue of de-merger. It is significant that the questionnaire provided strong support for the view that staff and management could talk honestly and openly about safety problems. Observation confirmed that management were taking a pro-active stance on safety and the HESACs provided a good example of taking the moral high ground.

The questionnaire confirmed a very strong belief that management were genuinely concerned about safety and observation supported the view that this concern was sincere. The General Manager was certainly believed to be concerned about safety, particularly about good housekeeping. The direct interest of the General Manager was exploited at Ffestiniog in the sense that direct approaches were made to him which tended to subvert line management authority. The Local Council was also used in this way to some extent. This approach was effective and therefore understandable but was resented by line management and supervisors.

The General Manager's profile and visibility was considered by many staff to be too low, particularly at Dinorwig and he was regarded by a significant number of staff as distant and aloof. This is certainly in conflict with his stated intentions and may perhaps, to some extent, be due to an inwardly focused stance by top management during the establishment of PSB and a more outwardly focused stance as the business approaches de-merger.

Some senior staff, who needed contact time with the General Manager, found this difficult to achieve due to the demands of his schedule and the time he spent away from PSB locations.

The senior management team seemed to be united and co-ordinated and working with no evident internal tensions.

The questionnaire results on supervisory issues indicated relatively weak support for the proposition that *supervisors always ensure that staff understand their instructions* and disagreement with the propositions that *supervisors make sufficient checks on the work in progress to ensure it is being done properly* and *supervisors periodically inspect PPE*. Against these apparent indications of weak supervisory safety control, the proposition that *supervisors put production before safety* was strongly refuted. There was relatively poor support for the proposition that *staff are praised for working safely*. The difficulties of exercising effective supervision and discipline against the background of the relationships which develop in small and stable *family* communities, such as Ffestiniog, were highlighted during the study.

The sincerity of the PSB management commitment to safety has already been noted but a number of indicators, some discussed more fully below, suggest that this commitment is limited in its effectiveness.

These indicators include, the accident rate itself, which is certainly running at a significantly higher rate than other CEGB successor GENCOs, the standard of housekeeping, which was good in some areas but ranged from poor to extremely poor in many areas, the fact that the ISRS system was not meaningfully implemented and the fact that knowledge of risk assessment was very weak, at least during the early part of the study.

Significant accidents are rare in such a small workforce and therefore underlying unsatisfactory attitudes and behaviour may be difficult to detect until an incident highlights some worrying but hitherto latent problem.

The explanation of the apparent paradox of sincere management commitment coexisting with the situations revealed by the indicators referred to above, is probably a combination of an acceptance of standards which are believed to be tolerable and an inability to identify what further measures can be taken to effect an improvement. It is not a matter of whether commitment is sincere, or even visible, which it clearly is, but of how far the commitment goes.

It is assumed that PSB is committed to aspire to the standards of the very best world performers on management indices relating to profitability, productivity, availability, efficiency etc. If the stated NGC commitment is to be believed, safety performance ranks equally in importance to these other criteria and therefore PSB should aim to be equal to the best in the world on safety performance too. Individual incidents, although infrequent, reveal PSB's vulnerability and exposure to inadequate safety performance, especially to the effect of human error in an environment dominated by procedural controls.

It is acknowledged that there are many priorities competing for management attention and that safety management will receive a level of attention commensurate with the perceived mismatch between actual and acceptable standards of performance. The rest of the line management, supervisors and staff will react proportionately to the perceived level of management concern and demands.

C.7 Working Conditions and Environment

The poor and uneven standard of housekeeping has been referred to several times and the fact that housekeeping in areas in the public eye were generally good has also been noted. Staff believed strongly that their workplace was safe and there was moderate support for the view that their site was clean and tidy. This perhaps is an indication that the staff take the ambient conditions as the acceptable norm.

The poor housekeeping seems to result from items not removed at the end of a job as well as many cases of items being deliberately put in an inappropriate place. Either case reveals poor attitudes and the acceptance of low standards. A safety walk which was observed during the study was not carried out against any effective pre-determined standards, providing evidence that the monitoring procedure was ineffective in combating poor housekeeping standards.

Staff referred to time pressures as an explanation of poor housekeeping and supervisors referred to resource limitations as an explanation. Neither explanation was in any way convincing. The impression gained and also the view volunteered by staff, was that time pressures and staffing levels, particularly at Ffestiniog, were not over-demanding. The questionnaire also supported the view that time pressures were reasonable. Exhortation as a means of improving the situation was certainly futile as were periodic purges which tackled the symptoms not the disease.

There is no simple solution to this behavioural problem, which is a product of poor standards and attitude. The only practical approach would seem to be a co-ordinated and sustained drive as part of an overall strategy which effectively harnesses the efforts of the staff themselves. An attack on this problem is central to an improvement in safety culture and the management of safety and risk generally. It warrants a major project with budgeted resources, driven by a project team harnessing the participative efforts of different staff groups. The strategy must embrace on-going and continuing follow up to maintain behavioural standards at a sustained new level.

It is clear that PSB is regarded by staff as a good provider of material resources and of PPE in particular. It was also clear from observation that PPE was not always used where it was mandatory and that the use of PPE was not effectively enforced.

The view of PSB from the public perspective was sampled during the study and was generally impressive. It was noted that the non-use of PPE could be observed by the public at both sites. The condition of the buses and the standard of the public exhibition at Ffestiniog was markedly poorer than at Dinorwig and this was a major influence on

the morale of the staff at Ffestiniog involved in public visits. Whilst it is obvious that Dinorwig justifies a far more elaborate display and more extensive arrangements than Ffestiniog, the standard of provision at Ffestiniog, whilst being simpler, should reflect the same quality.

C.8 Risk Awareness and Risk Perception

The ACSNI Report identifies many factors as good indicators of a strong safety culture, which in various ways, relate to the integration of a risk assessment approach within the organisation and within the staff. A risk assessment approach has been implicit in the Health and Safety at Work Act for many years but recent legislation is framed around risk assessment requirements and risk assessment is the basis of the modern approach to the management of safety. Consideration of risk exposure is also the basis of the ISRS approach.

Much guidance had been issued by NGC Health and Safety Branch on the subject of risk assessment early in 1993, in response to new safety legislation but by mid 1994 this was largely unknown to the bulk of PSB staff, including most of the senior staff.

Questioning during interviews and discussions, dealt with risk assessment and this was a factor in prompting an increase in awareness of the topic. For this and no doubt other reasons, there was a much greater awareness of risk assessment by the end of the study, although no direct evidence was obtained of the extent to which risk assessment considerations influenced the attitudes or behaviour of staff and supervisors in the performance of their work. It is worth noting that research has indicated that the level of risk tends to be underestimated by those who work with the risks.

The housekeeping issues referred to above are linked to risk awareness and risk perception. For example, it is unlikely that someone leaving combustible waste in a cable flat consciously considers that it may add to a fire hazard or that someone leaving a switch-room cluttered or partially obstructing an emergency exit, considers the problems a congested floor could create if the room were to be filled with smoke or that those who tolerate an untidy workshop consider the additional hazards this introduces. Altogether, poor housekeeping creates a background of low standards and encourages further untidiness and a poor standard of self discipline. The questionnaire results suggest that respondents have positive attitudes to safety and they believe that management is genuinely interested in safety. They also believe quite strongly that their

sites are clean and tidy. This perhaps suggests that there is support for safety but that staff attitudes are trapped within existing standards.

This again suggests that there is a need for a project to move standards and behaviour with the ultimate objective of encouraging the development of better attitudes as a basis for improving safety culture. Such a project would need to move risk perception and awareness.

C.9 Safety Management Procedures

Although the study did not incorporate a detailed audit of safety management procedures, certain observations have already been made.

It must first be stated that PSB has a good inheritance of safety management procedures and has the resources and technical skill and knowledge to develop or modify existing procedures and to introduce new procedures.

Certain inaccuracies were noted in the PSB Safety Policy Statement which should be corrected.

New Safety Rules were introduced towards the end of the study but a number of people believed the Safety Rules were transmission oriented and the requirements of the Safety Rules were regularly ignored in respect of certain types of work. This suggests that an internal review of the Safety Rules should be undertaken to ensure that the Rules are based on specific PSB needs consistent with maintaining standards of safety.

Internal safety audit procedures are not universally well developed and a review of such procedures is necessary to ensure that the management role in monitoring the management of safety is being effectively performed.

It has been noted that ISRS is effectively not implemented in PSB although model ISRS standards are available and would greatly assist the implementation process. Few people in management and supervisory positions have any knowledge or involvement in the system. ISRS is merely a management system providing a systematic approach to safety management but as with any other management system, it requires the commitment of the organisation if it is to be effective. It is suggested that ISRS does provide an approach completely complementary to the need to enhance risk perception and awareness and to the establishing of better standards in certain areas. A decision should be made, either to implement ISRS wholeheartedly or to abandon it. The present adoption without implementation, is unacceptable.

The questionnaire indicated a high positive response for *in all circumstances I understand exactly what to do in an emergency evacuation*. On the face of it this is encouraging but it was noted that the individual responses varied widely which is a matter of concern given the nature of the sites. There is therefore scope for improving individual understanding of emergency evacuation procedures further.

The exercise conducted with the Fire Service during the study revealed many learning points and above all, a need for more exercises, as the performance of the Fire Service on this occasion left much to be desired and was quite unsatisfactory given the nature of the hazard.

C.10 Final Observations

Although further analysis of the questionnaire data will be undertaken, the results described here, together with the observations described in this Report, confirm that PSB has many factors operating in its favour in relation to its safety culture.

It has an extremely strong inheritance of well designed physical assets, in good condition, high quality procedures and systems, good human relations and an excellent base of technical knowledge and experience in its well qualified and motivated staff and management. It is also financially healthy. The preceding observations and discussion nevertheless indicate that there is considerable scope for further strengthening the safety culture of PSB.

Although specific actions could be taken, directed at each of the matters highlighted in this Report, it is suggested that a piecemeal approach would be inappropriate and the real need is for the implementation of a carefully considered strategy, embracing all relevant issues. This should be developed in a participative way between management and staff to maximise involvement and commitment. The plan developed should be systematic, with priorities and time-scales identified, resource implications worked out and resources budgeted. It is important that a safety culture initiative should be integrated with other management efforts in PSB and not be seen as something separate. For example, there would be much in common with any management initiative to improve quality.

The intention of the safety culture strategy is to improve risk awareness and perception and to influence attitudes and behaviour towards the acceptance and expectation of higher standards. The strategy should therefore include practical safety and risk awareness workshops for staff. These should cover the cost of losses, human behaviour

aspects, safety culture issues and supervisory implications. Such workshops should be participative and draw upon the experience of the staff and require their active involvement.

It is also important to harness the active involvement and support of the staff not only in developing the strategy but in its implementation. It is therefore appropriate to establish teams within PSB to co-ordinate and provide direction for implementing the strategy within their work areas and work groups.

It is suggested that moving attitudes can best be achieved only if staff see a determined sustained and co-ordinated approach. Piecemeal efforts are likely to meet with scepticism and to end in failure. It is likely that most staff expect such initiatives to be short lived and to peter out. It is therefore vital that the strategy is carefully planned and based on a strong foundation of commitment binding on management and staff groups. The most important single factor in the success or failure of the strategy will be the commitment and focus of senior management. As de-merger approaches it is unrealistic to expect the necessary level of single-minded commitment by either staff or senior management. It is therefore suggested that a safety culture initiative should be undertaken after de-merger when it could serve as a means of binding the organisation and building pride in the independent company.

C.11 The Way Forward

The following staged approach is suggested: (no detail is given since it is important that this arises from the collective consideration and involvement of the staff and management of PSB)

- Discuss Report with staff in consultative forum
- Agree broad approach in principle
- Set up a balanced and representative team to consider implications and to develop strategy
- Identify priorities, times-scales and resources
- Establish safety and risk awareness workshops
- Establish implementation teams with terms of reference, responsibilities and budgets
- Periodic review of progress
- Amend or adjust programme

APPENDIX D - ACSNI PROMPT LIST

1 Review of Organisational Culture

Has the organisation evidence to demonstrate that:

- 1.1 Communications at all levels are founded on mutual trust?
- 1.2 All personnel understand and agree with corporate goals and the subordinate goals of their work group?
- 1.3 All personnel understand and agree with the means adopted to achieve corporate and work group goals?
- 1.4 The work practices of the organisation are under continuous review to ensure timely responses to changes in the internal or external environment?
- 1.5 Managers and supervisors demonstrate care and concern for everyone affected by the business?
- 1.6 Managers and supervisors take an interest in the personnel, as well as the work problems of their subordinates?
- 1.7 Managers and supervisors have been trained in leadership skills and adopt a democratic and not an authoritarian leadership style?
- 1.8 Workforce participation in decision making is not confined to peripheral issues?
- 1.9 Job satisfaction is maintained by, for example, verbal praise from supervisors and peers, equitable systems of promotion, minimisation of lay-offs and the maintenance of a clean and comfortable working environment?
- 1.10 The organisation expects the highest standards of competence and commitment of all its employees but retribution and blame are not seen as the purpose of investigations when things go wrong?
- 1.11 An appropriate distribution of both young and more experienced socially more mature employees is maintained in the work force?
- 1.12 The organisation only recruits suitable personnel but no automatic presumption is made that individuals are immediately competent to carry out the tasks assigned to them?

2 Review of Safety Culture

2.1 Policy, Planning, Organisation and Communication

Has the organisation evidence to demonstrate that:

- 2.1.1 The Chief Executive takes a personal and informed interest in safety?
- 2.1.2 The Chief Executive and the Board take explicit and continuing steps to ensure that their interest in and commitment to, safety, is known to all personnel?
- 2.1.3 A positive commitment to safety is visible throughout the management chain?
- 2.1.4 Safety is managed in a similar way to other aspects of the business and is as much the responsibility of line management as any other function?
- 2.1.5 Safety practitioners have high professional status within the organisation with direct access to the Chief Executive or other appropriate Board member?
- 2.1.6 Safety committees have high status in the organisation, operate proactively, and publicise their work throughout the organisation?
- 2.1.7 Managers at all levels and supervisors, spend time on the 'shop-floor' discussing safety matters and that steps are taken to ensure that all personnel hear of the visits and the matters discussed?
- 2.1.8 Managers and supervisors spend time commending safe behaviour as well as expressing concern if safety procedures are not being observed?
- 2.1.9 There are multiple channels for two-way communication on safety matters, including both formal and informal modes?
- 2.1.10 Safety representatives play a valued part in promoting a positive safety culture and in particular, contribute to the development of open communications?
- 2.1.11 Specially convened discussion/focus groups are established to consider the safety aspects of new projects?
- 2.1.12 Everyone in the organisation talks about safety as a natural part of everyday conversation?
- 2.1.13 Everyone in the organisation recognises the futility of mere exhortation to think and act safely as a means of promoting good safety performance?

2.2 Hazard Management

Latent (decision) failures; has the organisation taken explicit steps to prevent and detect:

- 2.2.1 Cases where managers with responsibility for the development or implementation of safe operating procedures fail to:

- (a) search for and identify, all relevant hazards?
- (b) assess risks accurately?
- (c) select workable and effective control solutions?
- (d) adopt appropriate measures to monitor and review the adequacy of the procedures?
- (e) determine whether foreseeable active failures are likely to be the result of errors at the skill- or rule- or knowledge- based levels or the result of violations?
- (f) minimise or eliminate sources of conflict between production and safety?
- (g) ensure that all relevant personnel have had an opportunity to comment on the procedures before finalisation or implementation?
- (h) ensure that all personnel are adequately trained, instructed and motivated to follow safe operating procedures?

2.2.2 Cases where managers personally commit violations of safety procedures or professional good practice?

2.2.3 Cases where personnel fail (as a consequence of errors and/or violations) to:

- (a) search for and identify all relevant hazards?
- (b) match their perception of risk to the actual risk magnitude?
- (c) accept personal responsibility for action?
- (d) follow systems of work where specified or otherwise adopt a safe method of work?
- (e) continuously monitor and review the magnitude of risks to which they are exposed and the effectiveness of the steps taken to keep the dangers under control?

Do the organisation's plans for preventing and detecting latent and active failures take explicit account of the following:

2.2.4 Managers, supervisors and other personnel may tend to underestimate the magnitude of risks:

- (a) with no significant potential?

(b) where the consequences are delayed (e.g. a long latent period between exposure and harm)?

(c) affecting people outside the immediate work group?

(d) where perceptions may not be adjusted sufficiently in the light of new information?

(e) where snap judgements are made on the basis of extrapolated information about other hazards?

2.2.5 Managers, supervisors and other personnel may tend to overestimate their ability to assess and control risks:

(a) where hazards have been encountered for long periods without apparent adverse effect?

(b) where the hazards present opportunities for ego enhancement (e.g. public displays of daring (macho-image); managers seeking to portray decisiveness)?

(c) where substantial benefits accrue?

(d) when the assessment is made by a volunteer?

2.2.6 Managers, supervisors and other personnel may have an impaired ability to cope with risks:

(a) when affected by life event stressors (e.g. bereavement, divorce)?

(b) when under stress as a result of a lack of confidence in the established procedures?

(c) when they believe that they have no ability to influence their own destiny or that of others (fatalism)?

Has the organisation adopted the following measures for improving people's perceptions of risks and/or ability and commitment to control risks:

2.2.7 A scheme to identify managers, supervisors and other personnel who may:

(a) be subject to life-event stressors?

(b) lack confidence in the effectiveness of prevention?

(c) harbour resentment or distrust of the organisation?

(d) have an adventurous outlook on risks?

2.2.8 Steps to increase individual belief in their own ability to control events?

2.2.8 Steps to erode the peer approval of risk taking?

2.2.10 Discussion groups to talk through individual perceptions of risk and preventive measures?

2.2.11 Safety training founded on:

(a) a clear recognition and understanding of the likely distortions of peoples' perceptions of risk magnitudes and corrective measures?

(b) the need for refresher training to counter peoples' changes in perceptions over time?

(c) feedback of accident/near miss data?

(d) explanations of not just how a job must be done but why it must be done that way?

(e) the need for team building?

2.3 Monitoring and Review

2.3.1 Has the organisation taken explicit steps to determine how its corporate goals compare with those of the local community and society at large?

2.3.2 Is the Board seen to receive regular safety reports, to review safety performance periodically and to publicise the action it has taken?

2.3.3 Has the organisation:

(a) a plan to review and where necessary improve its safety culture?

(b) devised methods for selecting, quantifying and measuring (auditing) key indicators of safety culture?

(c) reviewed and where necessary, changed its organisational aims and structure to make manifest its commitment to safety?

(d) taken steps to ensure that safety decisions are acted upon without delay?

2.3.4 Have members of the organisation been trained to:

(a) carry out a review of safety culture?

(b) devise and validate key indicators of safety culture?

(c) prioritise safety culture goals arising from a review?

(d) draw up an action plan to improve the safety culture of the organisation in priority areas?

(e) monitor the implementation and effectiveness of plans to improve the safety culture?

2.3.5 Has the organisation made arrangements to encourage reflection on and to elicit the views of all personnel about:

(a) the overall organisational culture?

(b) the safety culture of the organisation?

(c) their perceptions of the attitudes of others in the organisation, about safety?

(d) their perceptions of risk?

(e) their perceptions of the effectiveness of preventive measures?

(f) themselves (self-assessment)?

2.3.6 Has the organisation introduced incident investigation procedures which take full account of:

(a) multi-causality?

(b) the need to explore the incidence of latent as well as active failure?

(c) the need to continue the investigation, even when an apparent cause has been found, to determine further causal factors?

(d) the importance of accepting that the ultimate responsibility lies with the organisation, rather than merely assigning blame to individuals?

APPENDIX E – QUESTIONNAIRES

Covering Letter – First Questionnaire, March 1995

First Questionnaire to PSB Staff

Covering Letter – Second Questionnaire, February 1997

Second Questionnaire to First Hydro Staff

ASTON UNIVERSITY

Date as postmark



MECHANICAL AND ELECTRICAL
ENGINEERING

HEALTH AND SAFETY UNIT
Head: Professor R T Booth

Dear

Safety Culture Research Project - Questionnaire to PSB Staff

As you may know, I am carrying out research in PSB into safety culture. In the last few months I have managed to talk to quite a number of PSB staff and I am grateful for the help I have been given. I now need to get views from a much wider range of people than I have been able to speak to individually.

I would be very grateful if you would complete the attached questionnaire. It should only take about 15 minutes.

So that I can analyse the results, I need to know what type of work you do and your work location but your name will not appear on the form so that all replies will remain anonymous. The forms will only be seen by myself and my co-researchers at Aston University. However, your views are important because the results of the analysis will be transmitted to PSB management and will be made available to staff.

It is important that I get the honest views of as many people as possible so please do take the time to fill in the questionnaire and return it to me: c/o Aston University, Health and Safety Unit in the reply-paid envelope provided.

Your help is very much appreciated.

Yours sincerely

Bryan O'Loughlin

Enc.

March 1995

SAFETY CULTURE QUESTIONNAIRE TO PSB STAFF

I am undertaking research into factors which could influence the Safety Culture of PSB. The questions in this questionnaire have been designed to find out how people feel about those factors. The questionnaire has been made as simple as possible to complete.

Most of the questions consist of a statement against which you are required to circle one of nine numbers on a scale from "1" to "9" depending on how strongly you agree or disagree. The format is like this:

strongly disagree				neutral				strongly agree	
1	2	3	4	5	6	7	8	9	n/a

If you strongly agree with the statement then you should circle 9, while if you strongly disagree you should circle 1. If you find yourself in-between you should circle one of the number depending on how much you agree or disagree. It is important that you answer all the questions, although if you believe the question does not apply to your job then circle "not applicable (n/a)" instead of a number. If you want to comment on any of the questions please write your comments on the last page of the questionnaire.

Please complete the details which indicate your work location, the type of work you do and which job group/category you are in. This information is essential in analysing the results.

Please return the completed questionnaire in the envelope provided. All replies will remain confidential and will be treated anonymously.

Thank you for your help.

Yours sincerely

Bryan O'Loughlin

Enc.

SAFETY CULTURE QUESTIONNAIRE TO PSB STAFF

Please circle one of the numbers on the scale of 1 to 9 depending on how strongly you agree or disagree with the following statements. Circle "n/a" if you feel the statement is not applicable to your job.

	strongly disagree								strongly agree	
1. PSB policy is effectively communicated to individuals	1	2	3	4	5	6	7	8	9	n/a
2. Staff are consulted about changes which affect them	1	2	3	4	5	6	7	8	9	n/a
3. Staff are promptly told about changes which affect them	1	2	3	4	5	6	7	8	9	n/a
4. Relevant staff get the opportunity to contribute to working procedures before they are implemented	1	2	3	4	5	6	7	8	9	n/a
5. Contributions from staff are taken into account in final procedures	1	2	3	4	5	6	7	8	9	n/a
6. Staff trust the management in PSB	1	2	3	4	5	6	7	8	9	n/a
7. Management trust the staff in PSB	1	2	3	4	5	6	7	8	9	n/a
8. I am provided with all the equipment needed to do my job	1	2	3	4	5	6	7	8	9	n/a
9. Time pressures for completing jobs are reasonable	1	2	3	4	5	6	7	8	9	n/a
10. Work is planned efficiently to avoid wasting time	1	2	3	4	5	6	7	8	9	n/a

Appendix E – Questionnaires and Covering Letters

	strongly disagree			neutral				strongly agree		
11. Supervisors always ensure that staff understand their instructions	1	2	3	4	5	6	7	8	9	n/a
12. Supervisors make sufficient checks on work in progress to ensure it is being done properly	1	2	3	4	5	6	7	8	9	n/a
13. Management care about the welfare of staff	1	2	3	4	5	6	7	8	9	n/a
14. PSB is understanding towards staff at times of bereavement or serious illness	1	2	3	4	5	6	7	8	9	n/a
15. Staff are blamed when they make mistakes	1	2	3	4	5	6	7	8	9	n/a
16. Staff and management can talk honestly and openly about safety problems	1	2	3	4	5	6	7	8	9	n/a
17. Management genuinely cares about safety	1	2	3	4	5	6	7	8	9	n/a
18. Staff are praised for working safely	1	2	3	4	5	6	7	8	9	n/a
19. The site where I work is clean and tidy	1	2	3	4	5	6	7	8	9	n/a
20. My workplace is safe	1	2	3	4	5	6	7	8	9	n/a
21. I feel I have enough knowledge and skill to avoid having an accident at work	1	2	3	4	5	6	7	8	9	n/a
22. I believe I have received enough training to do my job safely	1	2	3	4	5	6	7	8	9	n/a
23. In all circumstances I understand exactly what to do in an emergency evacuation	1	2	3	4	5	6	7	8	9	n/a

Appendix E – Questionnaires and Covering Letters

	strongly disagree		neutral		strongly agree					
24. Supervisors put production before safety	1	2	3	4	5	6	7	8	9	n/a
25. When under pressure, corners are cut on safety	1	2	3	4	5	6	7	8	9	n/a
26. Supervisors turn a blind eye to unsafe behaviour	1	2	3	4	5	6	7	8	9	n/a
27. Accidents are fully investigated	1	2	3	4	5	6	7	8	9	n/a
28. Staff who need to know are informed of the results of accident investigations	1	2	3	4	5	6	7	8	9	n/a
29. The safety related procedures which affect my job are practical and can always be applied	1	2	3	4	5	6	7	8	9	n/a
30. Safety procedures are always applied in full	1	2	3	4	5	6	7	8	9	n/a
31. I am informed about the activities of our Safety Committee	1	2	3	4	5	6	7	8	9	n/a
32. Personal Protective Equipment is always made available when it is required	1	2	3	4	5	6	7	8	9	n/a
33. The use of Personal Protective Equipment is strictly enforced	1	2	3	4	5	6	7	8	9	n/a
34. Personal Protective Equipment is always used whenever it is required	1	2	3	4	5	6	7	8	9	n/a
35. Supervisors periodically inspect Personal Protective Equipment	1	2	3	4	5	6	7	8	9	n/a
36. The NGC operational Safety Rules are practical and can be applied in all situations	1	2	3	4	5	6	7	8	9	n/a

Appendix E – Questionnaires and Covering Letters

	strongly disagree		neutral		strongly agree					
37. The NGC operational Safety Rules are applied in full	1	2	3	4	5	6	7	8	9	n/a
38. The NGC operational Safety Rules are broken because of production pressures	1	2	3	4	5	6	7	8	9	n/a
39. My workload is sometimes so heavy that I take short-cuts on safety	1	2	3	4	5	6	7	8	9	n/a
40. Knocks and bruises are bound to happen at work no matter how careful you are	1	2	3	4	5	6	7	8	9	n/a
41. There is no point in reporting hazards because no-one is likely to do anything about them	1	2	3	4	5	6	7	8	9	n/a
42. People make too much fuss about safety	1	2	3	4	5	6	7	8	9	n/a
43. If we always worked to the rules nothing would ever get done	1	2	3	4	5	6	7	8	9	n/a
44. At times I do put safety second	1	2	3	4	5	6	7	8	9	n/a
45. No-one here really cares about minor injuries sustained at work	1	2	3	4	5	6	7	8	9	n/a
46. It is not my responsibility to find solutions to safety-related problems	1	2	3	4	5	6	7	8	9	n/a
47. No-one here really cares about any health problems I have	1	2	3	4	5	6	7	8	9	n/a
48. I criticise anyone who in my opinion is not working in a safe way	1	2	3	4	5	6	7	8	9	n/a
49. If there were less pressure to complete work on time there would be fewer accidents	1	2	3	4	5	6	7	8	9	n/a

Appendix E – Questionnaires and Covering Letters

	strongly disagree			neutral				strongly agree		
50. There is little I can do to prevent myself or others from being injured at work	1	2	3	4	5	6	7	8	9	n/a
51. In PSB production is more important than the safety of staff	1	2	3	4	5	6	7	8	9	n/a

For the following questions please circle whichever applies:

52. The workplace is safer now than in the past	YES	NO
53. There is less attention to safety now than there used to be	YES	NO

Please provide the answers to the next two questions if you know them or circle "Don't Know".

54. The PSB safety target is	Don't know
55. The PSB current accident frequency rate is	Don't know

The following information is required in order to analyse the results.

My normal work location is (please tick one):

Bala House	
Ffestinog	
Dinorwig	

My job group is (please tick one):

PCH	
8	
7	
6	
5	
4	
3	
2	
1	
None of the above	

My type of Occupation is (please tick one):

SHIFT	Auxiliary Plant Attendant	
	Craftsman/Technician	
	Engineer	
	Production Assistant	
	Unit Operator/Assistant Unit Operator	
	None of the above	
DAY	Administration/Business Support	
	Commercial/Business Strategy	
	Craftsman/Technician	
	Engineer	
	Guides	
	Manager	
	Supervisor	
	Trainee/Apprentice	
	None of the above	

Appendix E – Questionnaires and Covering Letters

Please add any comments you would like to make on any of the questions:

QUESTION No.	COMMENT

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February 1997

SAFETY CULTURE QUESTIONNAIRE TO FIRST HYDRO STAFF

I am undertaking research into factors which could influence the Safety Culture of First Hydro. The questions in this questionnaire have been designed to find out how people feel about those factors. The questionnaire has been made as simple as possible to complete.

Most of the questions consist of a statement against which you are required to circle one of nine numbers on a scale from "1" to "9" depending on how strongly you agree or disagree. The format is like this:

strongly disagree				neutral				strongly agree	
1	2	3	4	5	6	7	8	9	n/a

If you strongly agree with the statement then you should circle 9, while if you strongly disagree you should circle 1. If you find yourself in-between you should circle one of the number depending on how much you agree or disagree. It is important that you answer all the questions, although if you believe the question does not apply to your job then circle "not applicable (n/a)" instead of a number. If you want to comment on any of the questions please write your comments on the last page of the questionnaire.

Please complete the details which indicate your work location, the type of work you do and which job group/category you are in. This information is essential in analysing the results.

Please return the completed questionnaire in the envelope provided. All replies will remain confidential and will be treated anonymously.

Thank you for your help.

Yours sincerely

Bryan O'Loughlin

Enc.

SAFETY CULTURE QUESTIONNAIRE TO FIRST HYDRO STAFF

Please circle one of the numbers on the scale of 1 to 9 depending on how strongly you agree or disagree with the following statements. Circle "n/a" if you feel the statement is not applicable to your job.

	strongly disagree								strongly agree	
1. First Hydro policy is effectively communicated to individuals	1	2	3	4	5	6	7	8	9	n/a
2. Staff are consulted about changes which affect them	1	2	3	4	5	6	7	8	9	n/a
3. Staff are promptly told about changes which affect them	1	2	3	4	5	6	7	8	9	n/a
4. Relevant staff get the opportunity to contribute to working procedures before they are implemented	1	2	3	4	5	6	7	8	9	n/a
5. Contributions from staff are taken into account in final procedures	1	2	3	4	5	6	7	8	9	n/a
6. Staff trust the management in First Hydro	1	2	3	4	5	6	7	8	9	n/a
7. Management trust the staff in First Hydro	1	2	3	4	5	6	7	8	9	n/a
8. I am provided with all the equipment needed to do my job	1	2	3	4	5	6	7	8	9	n/a
9. Time pressures for completing jobs are reasonable	1	2	3	4	5	6	7	8	9	n/a
10. Work is planned efficiently to avoid wasting time	1	2	3	4	5	6	7	8	9	n/a

Appendix E – Questionnaires and Covering Letters

	strongly disagree			neutral				strongly agree		
11. Supervisors always ensure that staff understand their instructions	1	2	3	4	5	6	7	8	9	n/a
12. Supervisors make sufficient checks on work in progress to ensure it is being done properly	1	2	3	4	5	6	7	8	9	n/a
13. Management care about the welfare of staff	1	2	3	4	5	6	7	8	9	n/a
14. First Hydro is understanding towards staff at times of bereavement or serious illness	1	2	3	4	5	6	7	8	9	n/a
15. Staff are blamed when they make mistakes.	1	2	3	4	5	6	7	8	9	n/a
16. Staff and management can talk honestly and openly about safety problems	1	2	3	4	5	6	7	8	9	n/a
17. Management genuinely cares about safety	1	2	3	4	5	6	7	8	9	n/a
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19. The site where I work is clean and tidy	1	2	3	4	5	6	7	8	9	n/a
20. My workplace is safe	1	2	3	4	5	6	7	8	9	n/a
21. I feel I have enough knowledge and skill to avoid having an accident at work	1	2	3	4	5	6	7	8	9	n/a
22. I believe I have received enough training to do my job safely	1	2	3	4	5	6	7	8	9	n/a

Appendix E – Questionnaires and Covering Letters

- | | | | | | | | | | | | |
|-----|---|-------------------|---|---------|---|---|---|---|----------------|---|-----|
| 23. | In all circumstances I understand exactly what to do in an emergency evacuation | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | n/a |
| | | strongly disagree | | neutral | | | | | strongly agree | | |
| 24. | Supervisors put production before safety | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | n/a |
| | | strongly disagree | | neutral | | | | | strongly agree | | |
| 25. | When under pressure, corners are cut on safety | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | n/a |
| | | strongly disagree | | neutral | | | | | strongly agree | | |
| 26. | Supervisors turn a blind eye to unsafe behaviour | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | n/a |
| | | strongly disagree | | neutral | | | | | strongly agree | | |
| 27. | Accidents are fully investigated | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | n/a |
| | | strongly disagree | | neutral | | | | | strongly agree | | |
| 28. | Staff who need to know are informed of the results of accident investigations | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | n/a |
| | | strongly disagree | | neutral | | | | | strongly agree | | |
| 29. | The safety related procedures which affect my job are practical and can always be applied | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | n/a |
| | | strongly disagree | | neutral | | | | | strongly agree | | |
| 30. | Safety procedures are always applied in full | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | n/a |
| | | strongly disagree | | neutral | | | | | strongly agree | | |
| 31. | I am informed about the activities of our Safety Committee | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | n/a |
| | | strongly disagree | | neutral | | | | | strongly agree | | |
| 32. | Personal Protective Equipment is always made available when it is required | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | n/a |
| | | strongly disagree | | neutral | | | | | strongly agree | | |
| 33. | The use of Personal Protective Equipment is strictly enforced | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | n/a |
| | | strongly disagree | | neutral | | | | | strongly agree | | |
| 34. | Personal Protective Equipment is always used whenever it is required | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | n/a |
| | | strongly disagree | | neutral | | | | | strongly agree | | |
| 35. | Supervisors periodically inspect Personal Protective Equipment | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | n/a |

Appendix E – Questionnaires and Covering Letters

	strongly disagree			neutral				strongly agree		
36. The First Hydro operational Safety Rules are practical and can be applied in all situations	1	2	3	4	5	6	7	8	9	n/a
37. The First Hydro operational Safety Rules are applied in full	1	2	3	4	5	6	7	8	9	n/a
38. The First Hydro operational Safety Rules are broken because of production pressures	1	2	3	4	5	6	7	8	9	n/a
39. My workload is sometimes so heavy that I take short-cuts on safety	1	2	3	4	5	6	7	8	9	n/a
40. Knocks and bruises are bound to happen at work <u>no</u> matter how careful you are	1	2	3	4	5	6	7	8	9	n/a
41. There is no point in reporting hazards because no-one is likely to do anything about them	1	2	3	4	5	6	7	8	9	n/a
42. People make too much fuss about safety	1	2	3	4	5	6	7	8	9	n/a
43. If we always worked to the rules nothing would ever get done	1	2	3	4	5	6	7	8	9	n/a
44. At times I do put safety second	1	2	3	4	5	6	7	8	9	n/a
45. No-one here really cares about minor injuries sustained at work	1	2	3	4	5	6	7	8	9	n/a
46. It is not my responsibility to find solutions to safety-related problems	1	2	3	4	5	6	7	8	9	n/a
47. No-one here really cares about any health problems I have	1	2	3	4	5	6	7	8	9	n/a

Appendix E – Questionnaires and Covering Letters

48. I criticise anyone who in my opinion is not working in a safe way

strongly disagree		neutral				strongly agree		
1	2	3	4	5	6	7	8	9

49. If there were less pressure to complete work on time there would be fewer accidents

strongly disagree		neutral				strongly agree		
1	2	3	4	5	6	7	8	9

50. There is little I can do to prevent myself or others from being injured at work

strongly disagree		neutral				strongly agree		
1	2	3	4	5	6	7	8	9

51. In First Hydro production is more important than the safety of staff

strongly disagree		neutral				strongly agree		
1	2	3	4	5	6	7	8	9

For the following questions please circle whichever applies:

52. The workplace is safer now than in the past

YES	NO
-----	----

53. There is less attention to safety now than there used to be

YES	NO
-----	----

Please provide the answers to the next two questions if you know them or circle "Don't Know".

54. The First Hydro safety target is

	Don't know
	Don't know

55. The First Hydro current accident frequency rate is

The following information is required in order to analyse the results.

My normal work location is (please tick one):

Bala House	
Ffestinog	
Dinorwig	

My job group is (please tick one):

PCH	
8	
7	
6	
5	
4	
3	
2	
1	
None of the above	

My type of Occupation is (please tick one):

SHIFT	Auxiliary Plant Attendant	
	Craftsman/Technician	
	Engineer	
	Production Assistant	
	Unit Operator/Assistant Unit Operator	
	None of the above	
DAY --	Administration/Business Support	
	Commercial/Business Strategy	
	Craftsman/Technician	
	Engineer	
	Guides	
	Manager	
	Supervisor	
	Trainee/Apprentice	
	None of the above	

Appendix E – Questionnaires and Covering Letters

Please add any comments you would like to make on any of the questions:

QUESTION No.	COMMENT

APPENDIX F – STATISTICAL TABLES

Contents

Responses to First Questionnaire – March 1995:

PSB as a whole

Bala House

Ffestiniog

Dinorwig

Responses to Second Questionnaire – February 1997:

First Hydro as a whole

Bala House

Ffestiniog

Dinorwig

Analysis of Variables (ANOVA):

Operational/ Non-operational sites

Shift/Days

Location/Shift

Dinorwig/Ffestiniog

Them/Us

Location/Them/Us

Factors identified by Factor Analysis

Composition of Factors

Comparison of Mean Responses for PSB and FH

Responses to First Questionnaire – March 1995

PSB as a whole Question - (expectation of affirmative answers)	Mean	Std Dev
32. Personal Protective Equipment is always made available whenever it is required	8.13	1.34
14. PSB is understanding towards staff at times of bereavement or serious illness	7.94	1.47
21. I feel I have enough knowledge and skill to avoid having an accident at work	7.85	2.21
17. Management genuinely cares about safety	7.73	1.63
8. I am provided with all the equipment needed to do my job	7.51	1.67
22. I believe I have received enough training to do my job safely	7.45	1.67
16. Staff and management can talk honestly and openly about safety problems	7.42	1.76
23. In all circumstances I understand exactly what to do in an emergency evacuation	7.40	1.87
27. Accidents are fully investigated	7.18	1.82
20. My workplace is safe	7.04	1.81
48. I criticise anyone who in my opinion is not working in a safe way	7.00	1.96
29. The safety related procedures which affect my job are practical and can always be applied	6.79	1.82
37. The NGC operational Safety Rules are applied in full	6.78	1.82
30. Safety procedures are always applied in full	6.66	2.02
13. Management care about the welfare of staff	6.63	1.81
31. I am informed about the activities of our safety committee	6.61	2.37
36. The NGC operational Safety Rules are practical and can be applied in all situations	6.45	1.92
9. Time pressures for completing jobs are reasonable	6.34	2.22
28. Staff who need to know are informed of the results of accident investigations	6.30	1.91
33. The use of Personal Protective Equipment is strictly enforced	6.28	2.22
34. Personal Protective Equipment is always used whenever it is required	6.20	2.18
11. Supervisors always ensure that staff understand their instructions	5.94	2.04
19. The site where I work is clean and tidy	5.93	2.32
18. Staff are praised for working safely	5.53	2.28
1. PSB policy is effectively communicated to individuals	5.53	2.01
2. Staff are consulted about changes which affect them	5.37	2.26
7. Management trust the staff in PSB	5.27	2.00
3. Staff are promptly told about changes which affect them	5.11	2.21
4. Relevant staff get the opportunity to contribute to working procedures before they are implemented	4.98	2.10
5. Contributions from staff are taken into account in final procedures	4.94	2.21
12. Supervisors make sufficient checks on work in progress to ensure it is being done properly	4.93	2.35
35. Supervisors periodically inspect Personal Protective Equipment	4.70	2.67
10. Work is planned efficiently to avoid wasting time	4.43	2.49
6. Staff trust the management in PSB	4.34	2.25

Responses to First Questionnaire – March 1995

PSB as a whole Question - (expectation of negative answer)	Mean	Std Dev
42. People make too much fuss about safety	2.21	1.79
50. There is little I can do to prevent myself or others from being injured at work	2.44	1.84
51. In PSB production is more important than safety	2.59	1.93
46. It is not my responsibility to find solutions to safety related problems	2.84	2.26
41. There is no point in reporting hazards because no-one is likely to do anything about them	2.93	2.22
45. No-one here really cares about minor injuries sustained at work	3.06	1.87
26. Supervisors turn a blind eye to unsafe behaviour	3.20	2.28
47. No-one here really cares about any health problems I have	3.21	2.11
43. If we always worked to the Rules nothing would ever get done	3.32	2.27
39. My workload is sometimes so heavy that I take short-cuts on safety	3.36	2.65
38. The NGC operational Safety Rules are broken because of production pressures	3.37	2.31
24. Supervisors put production before safety	3.44	2.24
44. At times I do put safety second	3.5	2.43
25. When under pressure, corners are cut on safety	4.01	2.44
49. If there were less pressure to complete work on time there would be fewer accidents	4.54	2.37
15. Staff are blamed when they make mistakes	4.92	2.09
40. Knocks and bruises are bound to happen at work no matter how careful you are	6.52	2.22

Responses to First Questionnaire – March 1995

Bala House Question - (expectation of affirmative answers)	Mean	Std Dev
21. I feel I have enough knowledge and skill to avoid having an accident at work	8.11	1.36
20. My workplace is safe	8.00	1.32
23. In all circumstances I understand exactly what to do in an emergency evacuation	7.89	1.36
32. Personal Protective Equipment is always made available whenever it is required	7.83	0.98
22. I believe I have received enough training to do my job safely	7.83	1.33
8. I am provided with all the equipment needed to do my job	7.78	0.97
19. The site where I work is clean and tidy	7.78	1.92
17. Management genuinely cares about safety	7.75	1.39
27. Accidents are fully investigated	7.67	0.82
14. PSB is understanding towards staff at times of bereavement or serious illness	7.56	2.55
16. Staff and management can talk honestly and openly about safety problems	7.43	1.40
33. The use of Personal Protective Equipment is strictly enforced	7.40	0.89
31. I am informed about the activities of our safety committee	7.37	0.52
29. The safety related procedures which affect my job are practical and can always be applied	7.17	1.17
30. Safety procedures are always applied in full	7.17	1.17
18. Staff are praised for working safely	6.57	1.27
9. Time pressures for completing jobs are reasonable	6.44	1.81
28. Staff who need to know are informed of the results of accident investigations	6.40	1.34
34. Personal Protective Equipment is always used whenever it is required	6.40	1.34
10. Work is planned efficiently to avoid wasting time	6.22	1.86
37. The NGC operational Safety Rules are applied in full	6.00	1.41
36. The NGC operational Safety Rules are practical and can be applied in all situations	6.00	1.41
13. Management care about the welfare of staff	5.78	2.82
1. PSB policy is effectively communicated to individuals	5.75	1.83
12. Supervisors make sufficient checks on work in progress to ensure it is being done properly	5.57	0.79
7. Management trust the staff in PSB	5.44	2.24
11. Supervisors always ensure that staff understand their instructions	5.43	1.27
35. Supervisors periodically inspect Personal Protective Equipment	5.25	0.50
3. Staff are promptly told about changes which affect them	5.22	2.58
5. Contributions from staff are taken into account in final procedures	5.11	2.52
4. Relevant staff get the opportunity to contribute to working procedures before they are implemented	5.00	2.69
2. Staff are consulted about changes which affect them	4.89	2.57
48. I criticise anyone who in my opinion is not working in a safe way	4.83	2.64
6. Staff trust the management in PSB	4.11	3.05

Responses to First Questionnaire – March 1995

Bala House - Question - (expectation of negative answer)	Mean	Std Dev
24. Supervisors put production before safety	1.4	0.89
26. Supervisors turn a blind eye to unsafe behaviour	1.8	0.84
25. When under pressure, corners are cut on safety	1.8	0.84
39. My workload is sometimes so heavy that I take short-cuts on safety	2.25	1.89
51. In PSB production is more important than safety	2.37	2.13
38. The NGC operational Safety Rules are broken because of production pressures	2.67	2.08
42. People make too much fuss about safety	2.86	3.08
46. It is not my responsibility to find solutions to safety related problems	2.86	1.77
50. There is little I can do to prevent myself or others from being injured at work	3.00	1.41
41. There is no point in reporting hazards because no-one is likely to do anything about them	3.29	2.81
43. If we always worked to the Rules nothing would ever get done	3.43	1.51
47. No-one here really cares about any health problems I have	3.44	1.94
45. No-one here really cares about minor injuries sustained at work	3.67	2.06
44. At times I do put safety second	3.67	2.33
49. If there were less pressure to complete work on time there would be fewer accidents	3.67	1.86
15. Staff are blamed when they make mistakes	5.55	2.24
40. Knocks and bruises are bound to happen at work no matter how careful you are	7.00	1.41

Responses to First Questionnaire – March 1995

Ffestiniog Question - (expectation of affirmative answers)	Mean	Std Dev
14. PSB is understanding towards staff at times of bereavement or serious illness	8.19	1.08
32. Personal Protective Equipment is always made available whenever it is required	7.91	1.77
21. I feel I have enough knowledge and skill to avoid having an accident at work	7.77	1.38
17. Management genuinely cares about safety	7.77	1.34
22. I believe I have received enough training to do my job safely	7.64	1.62
23. In all circumstances I understand exactly what to do in an emergency evacuation	7.41	1.68
16. Staff and management can talk honestly and openly about safety problems	7.38	1.83
37. The NGC operational Safety Rules are applied in full	7.37	1.71
27. Accidents are fully investigated	7.35	1.46
48. I criticise anyone who in my opinion is not working in a safe way	7.33	1.53
20. My workplace is safe	7.23	1.51
8. I am provided with all the equipment needed to do my job	7.14	2.25
31. I am informed about the activities of our safety committee	7.09	2.27
29. The safety related procedures which affect my job are practical and can always be applied	6.95	1.68
9. Time pressures for completing jobs are reasonable	6.76	2.11
36. The NGC operational Safety Rules are practical and can be applied in all situations	6.76	1.79
34. Personal Protective Equipment is always used whenever it is required	6.71	1.90
28. Staff who need to know are informed of the results of accident investigations	6.70	1.69
30. Safety procedures are always applied in full	6.68	2.01
13. Management care about the welfare of staff	6.68	1.61
33. The use of Personal Protective Equipment is strictly enforced	6.57	2.20
11. Supervisors always ensure that staff understand their instructions	6.50	1.40
19. The site where I work is clean and tidy	5.95	2.06
1. PSB policy is effectively communicated to individuals	5.73	2.14
35. Supervisors periodically inspect Personal Protective Equipment	5.57	2.67
2. Staff are consulted about changes which affect them	5.55	2.17
12. Supervisors make sufficient checks on work in progress to ensure it is being done properly	5.45	2.34
7. Management trust the staff in PSB	5.23	2.22
18. Staff are praised for working safely	5.09	1.92
3. Staff are promptly told about changes which affect them	5.00	2.14
4. Relevant staff get the opportunity to contribute to working procedures before they are implemented	4.95	2.44
5. Contributions from staff are taken into account in final procedures	4.38	2.06
6. Staff trust the management in PSB	3.72	2.35
10. Work is planned efficiently to avoid wasting time	3.67	2.08

Responses to First Questionnaire – March 1995

Ffestiniog - Question - (expectation of negative answer)	Mean	Std Dev
42. People make too much fuss about safety	2.00	1.58
50. There is little I can do to prevent myself or others from being injured at work	2.23	1.44
45. No-one here really cares about minor injuries sustained at work	2.45	1.37
51. In PSB production is more important than safety	2.82	1.94
46. It is not my responsibility to find solutions to safety related problems	2.86	2.87
41. There is no point in reporting hazards because no-one is likely to do anything about them	3.09	2.38
43. If we always worked to the Rules nothing would ever get done	3.09	2.18
38. The NGC operational Safety Rules are broken because of production pressures	3.12	2.24
47. No-one here really cares about any health problems I have	3.38	2.35
44. At times I do put safety second	3.45	2.46
39. My workload is sometimes so heavy that I take short-cuts on safety	3.62	2.87
24. Supervisors put production before safety	3.90	2.12
26. Supervisors turn a blind eye to unsafe behaviour	4.15	2.32
25. When under pressure, corners are cut on safety	4.45	2.30
49. If there were less pressure to complete work on time there would be fewer accidents	4.76	2.47
15. Staff are blamed when they make mistakes	5.20	1.85
40. Knocks and bruises are bound to happen at work no matter how careful you are	6.61	2.17

Responses to First Questionnaire – March 1995

Dinorwig Question - (expectation of affirmative answers)	Mean	Std Dev
32. Personal Protective Equipment is always made available whenever it is required	8.26	1.17
14. PSB is understanding towards staff at times of bereavement or serious illness	7.91	1.39
21. I feel I have enough knowledge and skill to avoid having an accident at work	7.84	1.12
17. Management genuinely cares about safety	7.71	1.58
8. I am provided with all the equipment needed to do my job	7.61	1.48
16. Staff and management can talk honestly and openly about safety problems	7.44	1.80
22. I believe I have received enough training to do my job safely	7.33	1.73
23. In all circumstances I understand exactly what to do in an emergency evacuation	7.33	2.02
48. I criticise anyone who in my opinion is not working in a safe way	7.11	1.91
27. Accidents are fully investigated	7.06	2.01
20. My workplace is safe	6.82	1.95
13. Management care about the welfare of staff	6.75	1.69
29. The safety related procedures which affect my job are practical and can always be applied	6.68	1.95
37. The NGC operational Safety Rules are applied in full	6.61	1.86
30. Safety procedures are always applied in full	6.60	2.11
36. The NGC operational Safety Rules are practical and can be applied in all situations	6.36	2.01
31. I am informed about the activities of our safety committee	6.31	2.54
9. Time pressures for completing jobs are reasonable	6.16	2.32
28. Staff who need to know are informed of the results of accident investigations	6.14	2.03
33. The use of Personal Protective Equipment is strictly enforced	6.07	2.29
34. Personal Protective Equipment is always used whenever it is required	5.98	2.33
11. Supervisors always ensure that staff understand their instructions	5.78	2.29
19. The site where I work is clean and tidy	5.63	2.38
18. Staff are praised for working safely	5.56	2.46
1. PSB policy is effectively communicated to individuals	5.39	2.01
2. Staff are consulted about changes which affect them	5.37	2.28
7. Management trust the staff in PSB	5.25	1.90
3. Staff are promptly told about changes which affect them	5.14	2.22
5. Contributions from staff are taken into account in final procedures	5.13	2.21
4. Relevant staff get the opportunity to contribute to working procedures before they are implemented	4.98	1.89
12. Supervisors make sufficient checks on work in progress to ensure it is being done properly	4.64	2.45
6. Staff trust the management in PSB	4.62	2.05
10. Work is planned efficiently to avoid wasting time	4.42	2.61
35. Supervisors periodically inspect Personal Protective Equipment	4.31	2.70

Responses to First Questionnaire – March 1995

Dinorwig - Question - (expectation of negative answer)	Mean	Std Dev
42. People make too much fuss about safety	2.21	1.68
50. There is little I can do to prevent myself or others from being injured at work	2.46	2.02
51. In PSB production is more important than safety	2.54	1.92
41. There is no point in reporting hazards because no-one is likely to do anything about them	2.82	2.11
46. It is not my responsibility to find solutions to safety related problems	2.84	2.34
26. Supervisors turn a blind eye to unsafe behaviour	2.98	2.24
47. No-one here really cares about any health problems I have	3.11	2.06
45. No-one here really cares about minor injuries sustained at work	3.24	1.99
39. My workload is sometimes so heavy that I take short-cuts on safety	3.34	2.63
43. If we always worked to the Rules nothing would ever get done	3.39	2.41
38. The NGC operational Safety Rules are broken because of production pressures	3.43	2.38
24. Supervisors put production before safety	3.45	2.28
44. At times I do put safety second	3.50	2.46
25. When under pressure, corners are cut on safety	4.05	2.50
49. If there were less pressure to complete work on time there would be fewer accidents	4.54	2.42
15. Staff are blamed when they make mistakes	4.71	2.06
40. Knocks and bruises are bound to happen at work no matter how careful you are	6.61	2.17

Responses to Second Questionnaire – February 1997

FH as a whole	Mean	Std Dev
Question - (expectation of affirmative answers)		
32. Personal Protective Equipment is always made available whenever it is required	7.93	1.16
14. FH is understanding towards staff at times of bereavement or serious illness	7.90	1.34
23. In all circumstances I understand exactly what to do in an emergency evacuation	7.58	1.93
21. I feel I have enough knowledge and skill to avoid having an accident at work	7.36	1.43
8. I am provided with all the equipment needed to do my job	7.32	1.58
17. Management genuinely cares about safety	7.29	1.68
22. I believe I have received enough training to do my job safely	7.09	1.74
48. I criticise anyone who in my opinion is not working in a safe way	7.07	1.59
16. Staff and management can talk honestly and openly about safety problems	7.00	1.63
27. Accidents are fully investigated	6.82	1.87
20. My workplace is safe	6.75	1.84
37. The NGC operational Safety Rules are applied in full	6.52	1.90
36. The NGC operational Safety Rules are practical and can be applied in all situations	6.47	1.83
30. Safety procedures are always applied in full	6.42	2.05
31. I am informed about the activities of our safety committee	6.42	2.26
13. Management care about the welfare of staff	6.38	2.27
28. Staff who need to know are informed of the results of accident investigations	6.38	2.16
29. The safety related procedures which affect my job are practical and can always be applied	6.35	1.86
33. The use of Personal Protective Equipment is strictly enforced	6.19	2.20
19. The site where I work is clean and tidy	6.17	1.97
34. Personal Protective Equipment is always used whenever it is required	6.15	2.21
18. Staff are praised for working safely	6.15	2.13
9. Time pressures for completing jobs are reasonable	6.00	2.15
11. Supervisors always ensure that staff understand their instructions	5.98	1.84
1. FH policy is effectively communicated to individuals	5.98	1.96
7. Management trust the staff in FH	5.58	1.91
2. Staff are consulted about changes which affect them	5.45	2.15
12. Supervisors make sufficient checks on work in progress to ensure it is being done properly	5.29	2.10
3. Staff are promptly told about changes which affect them	5.26	2.05
35. Supervisors periodically inspect Personal Protective Equipment	5.18	2.42
4. Relevant staff get the opportunity to contribute to working procedures before they are implemented	5.17	1.94
5. Contributions from staff are taken into account in final procedures	5.00	2.00
6. Staff trust the management in FH	5.00	2.20
10. Work is planned efficiently to avoid wasting time	4.62	2.12

Responses to Second Questionnaire – February 1997

FII as a whole Question - (expectation of negative answer)	Mean	Std Dev
42. People make too much fuss about safety	2.26	1.97
46. It is not my responsibility to find solutions to safety related problems	2.62	1.91
50. There is little I can do to prevent myself or others from being injured at work	2.71	2.12
51. In FH production is more important than safety	2.91	1.99
45. No-one here really cares about minor injuries sustained at work	3.12	2.08
44. At times I do put safety second	3.13	2.26
39. My workload is sometimes so heavy that I take short-cuts on safety	3.14	2.28
41. There is no point in reporting hazards because no-one is likely to do anything about them	3.15	2.26
26. Supervisors turn a blind eye to unsafe behaviour	3.17	2.17
38. The NGC operational Safety Rules are broken because of production pressures	3.31	2.19
24. Supervisors put production before safety	3.40	2.02
25. When under pressure, corners are cut on safety	3.46	2.18
47. No-one here really cares about any health problems I have	3.67	2.55
43. If we always worked to the Rules nothing would ever get done	3.67	2.41
15. Staff are blamed when they make mistakes	4.56	1.70
49. If there were less pressure to complete work on time there would be fewer accidents	4.68	2.37
40. Knocks and bruises are bound to happen at work no matter how careful you are	6.24	2.25

Responses to Second Questionnaire – February 1997

Bala House - FH Question - (expectation of affirmative answers)	Mean	Std Dev
20. My workplace is safe	8.00	1.00
32. Personal Protective Equipment is always made available whenever it is required	8.00	1.41
17. Management genuinely cares about safety	8.00	1.73
27. Accidents are fully investigated	8.00	1.41
14. FH is understanding towards staff at times of bereavement or serious illness	8.00	1.73
16. Staff and management can talk honestly and openly about safety problems	8.00	1.41
28. Staff who need to know are informed of the results of accident investigations	8.00	1.41
22. I believe I have received enough training to do my job safely	7.80	1.09
21. I feel I have enough knowledge and skill to avoid having an accident at work	7.60	1.34
23. In all circumstances I understand exactly what to do in an emergency evacuation	7.60	1.67
19. The site where I work is clean and tidy	7.60	0.89
31. I am informed about the activities of our safety committee	7.40	1.67
7. Management trust the staff in FH	7.40	0.54
8. I am provided with all the equipment needed to do my job	7.2	2.39
33. The use of Personal Protective Equipment is strictly enforced	7.20	1.79
29. The safety related procedures which affect my job are practical and can always be applied	7.20	1.79
34. Personal Protective Equipment is always used whenever it is required	7.20	1.79
13. Management care about the welfare of staff	7.20	3.03
1. FH policy is effectively communicated to individuals	7.20	1.09
48. I criticise anyone who in my opinion is not working in a safe way	7.20	1.48
30. Safety procedures are always applied in full	7.00	1.58
18. Staff are praised for working safely	7.00	2.00
5. Contributions from staff are taken into account in final procedures	7.00	3.08
11. Supervisors always ensure that staff understand their instructions	6.80	1.09
37. The NGC operational Safety Rules are applied in full	6.75	1.71
12. Supervisors make sufficient checks on work in progress to ensure it is being done properly	6.60	1.14
3. Staff are promptly told about changes which affect them	6.60	1.67
36. The NGC operational Safety Rules are practical and can be applied in all situations	6.50	1.91
10. Work is planned efficiently to avoid wasting time	6.40	0.54
4. Relevant staff get the opportunity to contribute to working procedures before they are implemented	6.40	2.88
6. Staff trust the management in FH	6.00	2.34
2. Staff are consulted about changes which affect them	5.80	2.77
35. Supervisors periodically inspect Personal Protective Equipment	5.50	1.00
9. Time pressures for completing jobs are reasonable	5.00	1.87

Responses to Second Questionnaire – February 1997

Bala House - FH Question - (expectation of negative answer)	Mean	Std Dev
51. In FH production is more important than safety	1.60	0.89
42. People make too much fuss about safety	2.00	1.73
50. There is little I can do to prevent myself or others from being injured at work	2.00	1.00
41. There is no point in reporting hazards because no-one is likely to do anything about them	2.00	1.73
26. Supervisors turn a blind eye to unsafe behaviour	2.20	1.30
46. It is not my responsibility to find solutions to safety related problems	2.20	1.79
47. No-one here really cares about any health problems I have	2.20	1.79
45. No-one here really cares about minor injuries sustained at work	2.20	1.79
25. When under pressure, corners are cut on safety	2.40	1.34
43. If we always worked to the Rules nothing would ever get done	2.40	1.67
44. At times I do put safety second	2.40	1.67
39. My workload is sometimes so heavy that I take short-cuts on safety	2.60	1.67
38. The NGC operational Safety Rules are broken because of production pressures	2.75	2.06
24. Supervisors put production before safety	3.20	2.49
49. If there were less pressure to complete work on time there would be fewer accidents	3.40	1.52
15. Staff are blamed when they make mistakes	4.60	1.67
40. Knocks and bruises are bound to happen at work no matter how careful you are	4.80	1.79

Responses to Second Questionnaire – February 1997

Ffestiniog -FH Question - (expectation of affirmative answers)	Mean	Std Dev
32. Personal Protective Equipment is always made available whenever it is required	8.05	1.03
14. FH is understanding towards staff at times of bereavement or serious illness	7.94	1.24
31. I am informed about the activities of our safety committee	7.60	1.59
48. I criticise anyone who in my opinion is not working in a safe way	7.59	1.06
23. In all circumstances I understand exactly what to do in an emergency evacuation	7.47	2.06
21. I feel I have enough knowledge and skill to avoid having an accident at work	7.35	1.50
37. The NGC operational Safety Rules are applied in full	7.31	1.62
17. Management genuinely cares about safety	7.29	1.40
16. Staff and management can talk honestly and openly about safety problems	7.23	1.14
36. The NGC operational Safety Rules are practical and can be applied in all situations	7.17	1.63
30. Safety procedures are always applied in full	7.17	1.24
20. My workplace is safe	7.06	1.25
33. The use of Personal Protective Equipment is strictly enforced	7.00	2.16
8. I am provided with all the equipment needed to do my job	6.87	1.78
28. Staff who need to know are informed of the results of accident investigations	6.81	2.17
27. Accidents are fully investigated	6.75	1.84
34. Personal Protective Equipment is always used whenever it is required	6.75	1.88
13. Management care about the welfare of staff	6.70	2.11
22. I believe I have received enough training to do my job safely	6.59	2.21
29. The safety related procedures which affect my job are practical and can always be applied	6.53	1.87
9. Time pressures for completing jobs are reasonable	6.41	2.18
19. The site where I work is clean and tidy	6.41	1.73
11. Supervisors always ensure that staff understand their instructions	6.29	1.61
1. FH policy is effectively communicated to individuals	6.18	2.01
18. Staff are praised for working safely	6.00	1.90
7. Management trust the staff in FH	5.81	1.60
35. Supervisors periodically inspect Personal Protective Equipment	5.56	2.71
2. Staff are consulted about changes which affect them	5.53	2.32
10. Work is planned efficiently to avoid wasting time	5.41	1.90
12. Supervisors make sufficient checks on work in progress to ensure it is being done properly	5.12	1.63
4. Relevant staff get the opportunity to contribute to working procedures before they are implemented	5.12	1.93
5. Contributions from staff are taken into account in final procedures	5.06	2.01
6. Staff trust the management in FH	5.00	2.40
3. Staff are promptly told about changes which affect them	4.41	2.37

Responses to Second Questionnaire – February 1997

Ffestiniog - FH Question - (expectation of negative answer)	Mean	Std Dev
42. People make too much fuss about safety	2.35	2.06
46. It is not my responsibility to find solutions to safety related problems	2.73	2.22
45. No-one here really cares about minor injuries sustained at work	2.94	2.41
50. There is little I can do to prevent myself or others from being injured at work	3.00	2.80
39. My workload is sometimes so heavy that I take short-cuts on safety	3.19	2.43
26. Supervisors turn a blind eye to unsafe behaviour	3.25	2.43
43. If we always worked to the Rules nothing would ever get done	3.37	2.06
24. Supervisors put production before safety	3.37	1.93
25. When under pressure, corners are cut on safety	3.44	1.89
38. The NGC operational Safety Rules are broken because of production pressures	3.50	2.80
51. In FH production is more important than safety	3.56	2.75
41. There is no point in reporting hazards because no-one is likely to do anything about them	3.59	2.78
44. At times I do put safety second	3.70	2.52
47. No-one here really cares about any health problems I have	3.87	2.92
15. Staff are blamed when they make mistakes	4.44	1.26
49. If there were less pressure to complete work on time there would be fewer accidents	4.62	2.39
40. Knocks and bruises are bound to happen at work no matter how careful you are	5.75	2.21

Responses to Second Questionnaire – February 1997

Dinorwig - FH Question - (expectation of affirmative answers)	Mean	Std Dev
32. Personal Protective Equipment is always made available whenever it is required	7.91	1.18
14. FH is understanding towards staff at times of bereavement or serious illness	7.87	1.38
23. In all circumstances I understand exactly what to do in an emergency evacuation	7.61	1.97
8. I am provided with all the equipment needed to do my job	7.48	1.42
21. I feel I have enough knowledge and skill to avoid having an accident at work	7.33	1.46
17. Management genuinely cares about safety	7.19	1.79
22. I believe I have received enough training to do my job safely	7.19	1.60
48. I criticise anyone who in my opinion is not working in a safe way	6.87	1.76
16. Staff and management can talk honestly and openly about safety problems	6.80	1.78
27. Accidents are fully investigated	6.70	1.93
20. My workplace is safe	6.50	2.05
37. The NGC operational Safety Rules are applied in full	6.23	1.97
29. The safety related procedures which affect my job are practical and can always be applied	6.22	1.88
36. The NGC operational Safety Rules are practical and can be applied in all situations	6.20	1.89
13. Management care about the welfare of staff	6.13	2.28
30. Safety procedures are always applied in full	6.13	2.27
18. Staff are praised for working safely	6.09	2.26
28. Staff who need to know are informed of the results of accident investigations	6.07	2.17
31. I am informed about the activities of our safety committee	5.98	2.33
9. Time pressures for completing jobs are reasonable	5.96	2.19
19. The site where I work is clean and tidy	5.89	2.08
34. Personal Protective Equipment is always used whenever it is required	5.82	2.33
33. The use of Personal Protective Equipment is strictly enforced	5.80	2.20
1. FH policy is effectively communicated to individuals	5.76	2.00
11. Supervisors always ensure that staff understand their instructions	5.74	1.96
3. Staff are promptly told about changes which affect them	5.39	1.88
2. Staff are consulted about changes which affect them	5.35	2.07
7. Management trust the staff in FH	5.24	1.98
12. Supervisors make sufficient checks on work in progress to ensure it is being done properly	5.15	2.28
35. Supervisors periodically inspect Personal Protective Equipment	5.05	2.44
4. Relevant staff get the opportunity to contribute to working procedures before they are implemented	5.00	1.80
6. Staff trust the management in FH	4.82	2.10
5. Contributions from staff are taken into account in final procedures	4.69	1.74
10. Work is planned efficiently to avoid wasting time	4.15	2.16

Responses to Second Questionnaire – February 1997

Dinorwig - FH Question - (expectation of negative answer)	Mean	Std Dev
42. People make too much fuss about safety	2.24	2.01
46. It is not my responsibility to find solutions to safety related problems	2.62	1.87
50. There is little I can do to prevent myself or others from being injured at work	2.69	1.96
51. In FH production is more important than safety	2.84	1.71
44. At times I do put safety second	3.00	2.24
41. There is no point in reporting hazards because no-one is likely to do anything about them	3.13	2.11
39. My workload is sometimes so heavy that I take short-cuts on safety	3.16	2.35
45. No-one here really cares about minor injuries sustained at work	3.24	1.99
26. Supervisors turn a blind eye to unsafe behaviour	3.27	2.18
38. The NGC operational Safety Rules are broken because of production pressures	3.30	2.01
24. Supervisors put production before safety	3.47	2.06
25. When under pressure, corners are cut on safety	3.60	2.36
47. No-one here really cares about any health problems I have	3.73	2.50
43. If we always worked to the Rules nothing would ever get done	3.84	2.55
15. Staff are blamed when they make mistakes	4.54	1.83
49. If there were less pressure to complete work on time there would be fewer accidents	4.80	2.45
40. Knocks and bruises are bound to happen at work no matter how careful you are	6.57	2.28

ANOVA

Operational /non-operational sites

Question	Bala Hsc	Ffest/Din	Pop mn	p
10. Work is planned efficiently to avoid wasting time (p 449)	6.22	4.18	4.40	0.021
19. The site where I work is clean and tidy (p 484)	7.78	5.63	5.86	0.008
24. Supervisors put production before safety (p 504)	1.40	3.54	3.40	0.036
25. When under pressure, corners are cut on safety (p508)	1.80	4.15	4.00	0.036

Shift/days

Question	Shift	Days	Pop mn	p
1. PSB policy is effectively communicated to individuals (p 207)	5.73	5.41	5.51	0.012
3. Staff are promptly told about changes which affect them (p 215)	4.25	5.53	5.11	0.018
6. Staff trust the management in PSB (p 226)	3.29	4.78	4.29	0.015
33. The use of Personal Protective Equipment is strictly enforced (p 335)	5.50	6.60	6.24	0.017

Location/shift

24. Supervisors put production before safety (p 229)	Shift	Days	Pop Mn	p
Ffest	4.58	2.88	3.54	0.043 (Loc/shift)
Din	2.75	3.61		

Dinorwig/Ffestiniog

Question	Ffest	Din	Pop mn	p
35. Supervisors periodically inspect Personal Protective Equipment (p 343)	5.57	4.31	4.70	0.022
45. No-one here really cares about minor injuries sustained at work (p 383)	2.45	3.31	3.05	0.05

Them/us

(Them: Shift auxiliary plant attendant, shift craftsman/technician, shift production assistant, shift unit operator/assistant unit operator, day craftsman/technician)

(Us: Shift engineer, administrative/business support, commercial/business strategy, day engineer, manager, supervisor)

Question	Them	Us	Pop mn	p
5. Contributions from staff are taken into account in final procedures (p 22)	3.90	5.38	4.70	0.009
10. Work is planned efficiently to avoid wasting time (p 39)	3.30	4.74	4.08	0.018
13. Management care about the welfare of staff (p 51)	6.07	6.91	6.53	0.047
25. When under pressure, corners are cut on safety (p 99)	5.00	3.70	4.32	0.04
35. Supervisors periodically inspect Personal Protective Equipment (p 139)	3.63	5.58	4.62	0.004
37. The NGC operational Safety Rules are applied in full (p 148)	7.54	6.23	6.82	0.007
40. Knocks and bruises are bound to happen at work no matter how careful you are (p 159)	7.10	5.94	6.48	0.028
44. At times I do put safety second (p 177)	4.27	2.83	3.49	0.017
46. It is not my responsibility to find solutions to safety related problems (p 183)	3.63	2.44	3.00	0.05

N.B. Page numbers refer to the page in the original computer print-out.

Location/Them/us

26. Supervisors turn a blind eye to unsafe behaviour (p 103)	Them	Us	Pop Mn	p
Ffest	5.78	3.00	3.55	0.01 (loc/them/us)
Din	2.95	3.46		
36. The NGC operational Safety Rules are practical and can be applied in all situations (p 143)	Them	Us	Pop Mn	p
Ffest	6.11	7.00	6.43	0.029 (loc/them/us)
Din	7.21	6.71		

Factors Identified by Factor Analysis

Factor 1 Partnership	Factor 2 Safety Rules	Factor 3 Safety Arrangements	Factor 4 Safety Violations	Factor 5 Safety Supervision
Staff involvement Trust Communication Participation	Application Enforcement Practicability Conformity	Knowledge/skill Training Practicability Equipment provision	Supervisory attitude Safety vs productivity	Instruction Inspections Monitoring Praise

Composition of Factors

Factor 1:

Quest.	Text	Abbreviation	Correlation	PSB mean
5	Contributions from staff are taken into account in final procedures	STAFACC	.79471	4.94
6	Staff trust the management in PSB	STAFTRUS	.77850	4.34
3	Staff are promptly told about changes which affect them	STAFILD	.77021	5.11
4	Relevant staff get the opportunity to contribute to working procedures before they are implemented	STAFCONT	.76029	4.98
2	Staff are consulted about changes which affect them	STAFCON	.70391	5.37
7	Management trust the staff in PSB	MANTRUS	.60843	5.27
1	PSB policy is effectively communicated to individuals	EFFCOM	.52028	5.53

Factor 2:

Quest.	Text	Abbreviation	Correlation	PSB mean
37	The NGC operational Safety Rules are applied in full	SRAPP	.77350	6.78
33	The use of Personal Protective Equipment is strictly enforced	PPEENF	.73117	6.28
36	The NGC operational Safety Rules are practical and can be applied in all situations	SRPRAC	.72528	6.45
34	Personal Protective Equipment is always used whenever it is required	PPEUSE	.72284	6.20
30	Safety procedures are always applied in full	PROCAPP	.71554	6.66

Factor 3:

Quest.	Text	Abbreviation	Correlation	PSB mean
21	I feel I have enough knowledge and skill to avoid having an accident at work	KNSKL	.81387	7.85
22	I believe I have received enough training to do my job safely	TRNSAF	.81017	7.45
29	The safety related procedures which affect my job are practical and can always be applied	PROPRAC	.61361	6.79
23	In all circumstances I understand exactly what to do in an emergency evacuation	EMEVAC	.60312	7.40
32	Personal Protective Equipment is always made available whenever it is required	PPEAV	.48918	8.13
8	I am provided with all the equipment needed to do my job	PROVEQ	.44665	7.51

Factor 4:

Quest.	Text	Abbreviation	Correlation	PSB mean
24	Supervisors put production before safety	SUPPRDSF	.79198	3.44
25	When under pressure, corners are cut on safety	PRESCUT	.78974	4.01
26	Supervisors turn a blind eye to unsafe behaviour	SUPBLEY	.63037	3.20
49	If there were less pressure to complete work on time there would be fewer accidents	PRESACC	.60981	4.54

Factor 5:

Quest.	Text	Abbreviation	Correlation	PSB mean
11	Supervisors always ensure that staff understand their instructions	SUPUND	.70640	5.94
12	Supervisors make sufficient checks on work in progress to ensure it is being done properly	SUPCHK	.67975	4.93
18	Staff are praised for working safely	STAFPRS	.56940	5.53
35	Supervisors periodically inspect Personal Protective Equipment	SUPPPE	.54306	4.70

Comparison of Mean Responses for PSB and FH

Question	PSB Total	PSB BH	PSB Ffest	PSB Din	PSB Them	PSB Us	FH Total	FH BH	FH Ffest	FH Din	FH Them	FH Us
1. FH policy is effectively communicated to individuals	5.53	5.75	5.73	5.39	5.27	5.56	5.98	7.20	6.18	5.76	5.80	6.27
2. Staff are consulted about changes which affect them	5.37	4.89	5.55	5.37	5.07	5.27	5.45	5.80	5.53	5.35	5.20	5.86
3. Staff are promptly told about changes which affect them	5.11	5.22	5.00	5.14	4.63	5.23	5.26	6.60	4.41	5.39	4.68	6.07
4. Relevant staff get the opportunity to contribute to working procedures before they are implemented	4.98	5.00	4.95	4.98	4.25	5.25	5.17	6.40	5.12	5.00	4.20	5.90
5. Contributions from staff are taken into account in final procedures	4.94	5.11	4.38	5.13	3.90	5.32	5.00	7.00	5.06	4.69	3.80	6.00
6. Staff trust the management in FH	4.34	4.11	3.72	4.62	3.77	4.39	5.00	6.00	5.00	4.82	4.17	5.52
7. Management trust the staff in FH	5.27	5.44	5.23	5.25	5.04	5.28	5.58	7.40	5.81	5.24	4.71	6.34
8. I am provided with all the equipment needed to do my job	7.51	7.78	7.14	7.61	7.73	7.34	7.32	7.2	6.87	7.48	7.40	7.65
9. Time pressures for completing jobs are reasonable	6.34	6.44	6.76	6.16	6.60	5.91	6.00	5.00	6.41	5.96	6.80	5.59
10. Work is planned efficiently to avoid wasting time	4.43	6.22	3.67	4.42	3.30	5.04	4.62	6.40	5.41	4.15	3.76	5.31
11. Supervisors always ensure that staff understand their instructions	5.94	5.43	6.50	5.78	5.90	5.87	5.98	6.80	6.29	5.74	5.92	6.14
12. Supervisors make sufficient checks on work in progress to ensure it is being done properly	4.93	5.57	5.45	4.64	4.17	5.25	5.29	6.60	5.12	5.15	5.20	5.72
13. Management care about the welfare of staff	6.63	5.78	6.68	6.75	6.07	6.68	6.38	7.20	6.70	6.13	6.24	6.79
14. FH is understanding towards staff at times of bereavement or serious illness	7.94	7.56	8.19	7.91	8.25	7.70	7.90	8.00	7.94	7.87	8.00	8.10
15. Staff are blamed when they make mistakes	4.92	5.55	5.20	4.71	4.90	5.04	4.56	4.60	4.44	4.54	4.52	4.45
16. Staff and management can talk honestly and openly about safety problems	7.42	7.43	7.38	7.44	7.43	7.24	7.00	8.00	7.23	6.80	6.92	7.38
17. Management genuinely cares about safety	7.73	7.75	7.77	7.71	8.03	7.53	7.29	8.00	7.29	7.19	7.04	7.90
18. Staff are praised for working safely	5.53	6.57	5.09	5.56	4.83	5.95	6.15	7.00	6.00	6.09	6.20	6.48
19. The site where I work is clean and tidy	5.93	7.78	5.95	5.63	5.67	5.89	6.17	7.60	6.41	5.89	5.64	6.69
20. My workplace is safe	7.04	8.00	7.23	6.82	6.33	7.23	6.75	8.00	7.06	6.50	6.56	7.45
21. I feel I have enough knowledge and skill to avoid having an accident at work	7.85	8.11	7.77	7.84	7.83	7.91	7.36	7.60	7.35	7.33	6.88	7.93
22. I believe I have received enough training to do my job safely	7.45	7.83	7.64	7.33	7.20	7.49	7.09	7.80	6.59	7.19	6.60	8.03
23. In all circumstances I understand exactly what to do in an emergency evacuation	7.40	7.89	7.41	7.33	7.07	7.61	7.58	7.60	7.47	7.61	7.20	7.76
24. Supervisors put production before safety	3.44	1.4	3.90	3.45	4.10	2.87	3.40	3.20	3.37	3.47	3.76	2.89
25. When under pressure, comers are cut on safety	4.01	1.8	4.45	4.05	5.00	3.45	3.46	2.40	3.44	3.60	3.76	2.86
26. Supervisors turn a blind eye to unsafe behaviour	3.20	1.8	4.15	2.98	3.80	3.13	3.17	2.20	3.25	3.27	3.42	2.75
27. Accidents are fully investigated	7.18	7.67	7.35	7.06	7.21	7.54	6.82	8.00	6.75	6.70	6.79	7.03
28. Staff who need to know are informed of the results of accident investigations	6.30	6.40	6.70	6.14	6.26	6.47	6.38	8.00	6.81	6.07	5.83	7.25
29. The safety related procedures which affect my job are practical and can always be applied	6.79	7.17	6.95	6.68	6.83	6.69	6.35	7.20	6.53	6.22	6.32	6.72

Question	PSB Total	PSB BH	PSB Fest	PSB Din	PSB Them	PSB Us	FH Total	FH BH	FH Fest	FH Din	FH Them	FH Us
30. Safety procedures are always applied in full	6.66	7.17	6.68	6.60	6.67	6.62	6.42	7.00	7.17	6.13	6.72	6.62
31. I am informed about the activities of our safety committee	6.61	7.37	7.09	6.31	6.76	6.98	6.42	7.40	7.60	5.98	6.48	6.62
32. Personal Protective Equipment is always made available whenever it is required	8.13	7.83	7.91	8.26	7.90	8.13	7.93	8.00	8.05	7.91	7.88	8.18
33. The use of Personal Protective Equipment is strictly enforced	6.28	7.40	6.57	6.07	5.60	6.46	6.19	7.20	7.00	5.80	5.76	6.50
34. Personal Protective Equipment is always used whenever it is required	6.20	6.40	6.71	5.98	6.03	5.92	6.15	7.20	6.75	5.82	5.80	6.36
35. Supervisors periodically inspect Personal Protective Equipment	4.70	5.25	5.57	4.31	3.63	5.34	5.18	5.50	5.56	5.05	4.54	5.78
36. The NGC operational Safety Rules are practical and can be applied in all situations	6.45	6.00	6.76	6.36	6.86	6.05	6.47	6.50	7.17	6.20	6.22	6.78
37. The NGC operational Safety Rules are applied in full	6.78	6.00	7.37	6.61	7.54	6.20	6.52	6.75	7.31	6.23	6.61	6.82
38. The NGC operational Safety Rules are broken because of production pressures	3.37	2.67	3.12	3.43	3.22	3.62	3.31	2.75	3.50	3.30	3.18	2.71
39. My workload is sometimes so heavy that I take short-cuts on safety	3.36	2.25	3.62	3.34	3.38	3.62	3.14	2.60	3.19	3.16	3.30	2.71
40. Knocks and bruises are bound to happen at work no matter how careful you are	6.52	7.00	6.61	6.61	7.10	6.10	6.24	4.80	5.75	6.57	7.08	5.34
41. There is no point in reporting hazards because no-one is likely to do anything about them	2.93	3.29	3.09	2.82	3.13	2.69	3.15	2.00	3.59	3.13	3.33	2.41
42. People make too much fuss about safety	2.21	2.86	2.00	2.21	2.53	2.17	2.26	2.00	2.35	2.24	2.21	2.03
43. If we always worked to the Rules nothing would ever get done	3.32	3.43	3.09	3.39	3.97	2.98	3.67	2.40	3.37	3.84	3.91	3.24
44. At times I do put safety second	3.5	3.67	3.45	3.50	4.27	2.95	3.13	2.40	3.70	3.00	3.04	2.86
45. No-one here really cares about minor injuries sustained at work	3.06	3.67	2.45	3.24	3.20	3.17	3.12	2.20	2.94	3.24	3.96	2.21
46. It is not my responsibility to find solutions to safety related problems	2.84	2.86	2.86	2.84	3.63	2.51	2.62	2.20	2.73	2.62	3.21	1.86
47. No-one here really cares about any health problems I have	3.21	3.44	3.38	3.11	3.93	3.12	3.67	2.20	3.87	3.73	3.17	3.03
48. I criticise anyone who in my opinion is not working in a safe way	7.00	4.83	7.33	7.11	6.87	6.92	7.07	7.20	7.59	6.87	6.80	7.03
49. If there were less pressure to complete work on time there would be fewer accidents	4.54	3.67	4.76	4.54	5.10	4.41	4.68	3.40	4.62	4.80	4.44	4.21
50. There is little I can do to prevent myself or others from being injured at work	2.44	3.00	2.23	2.46	2.60	2.17	2.71	2.00	3.00	2.69	3.00	2.45
51. In FH production is more important than safety	2.59	2.37	2.82	2.54	2.62	2.88	2.91	1.60	3.56	2.84	3.04	2.41

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