HUMAN FACTORS, SHIFT WORK, AND ALERTNESS IN THE OFFSHORE OIL INDUSTRY

Author

Katharine R Parkes

Department of Experimental Psychology
University of Oxford
South Parks Road
Oxford OX1 3UD

London: HMSO

Health and Safety Executive - Offshore Technology Report
This report is published by the Health and Safety Executive as part of a series of reports of work which has been supported by funds formerly provided by the Department of Energy and lately by the Executive. Neither the Executive, the Department nor the contractors concerned assume any liability for the reports nor do they necessarily reflect the views or policy of the Executive or the Department.

Results, including detailed evaluation and, where relevant, recommendations stemming from their research projects are published in the OTH series of reports.

Background information and data arising from these research projects are published in the OTI series of reports.

HMSO

Standing order service

Placing a standing order with HMSO Books enables a customer to receive other titles in this series automatically as published. This saves time, trouble and expense of placing individual orders and avoids the problem of knowing when to do so.

For details please write to HMSO BOOKS (PC 13A/1). Publications Centre, PO Box 276, London SW8 5DT quoting reference 12.01.025.

The standing order service also enables customers to receive automatically as published all material of their choice which additionally saves extensive catalogue research. The scope and selectivity of the service has been extended by new techniques, and there are more than 3,500 classifications to choose from. A special leaflet describing the service in detail may be obtained on request.
'Work on a production platform is as many-faceted as a diamond'

The efficiency and well-being of oil industry employees is central to the safety and smooth running of production processes. This is particularly true of personnel working on oil platforms and rigs in the North Sea, who are exposed to demands and constraints over and above those experienced by their onshore counterparts. However, relatively little empirical research has been published into the implications of offshore work conditions for the well-being and working effectiveness of employees, in spite of the importance of these issues.

The research described in this report developed initially from the aim of comparing the work environment, performance, and well-being of onshore and offshore employees. A comparative approach of this kind potentially allows a more precise evaluation of the impact of offshore work than is possible if research is carried out only among offshore personnel. In this context, control-room operators (the participants in the present study) are a particularly relevant occupational group; process-control work, whether carried out onshore or offshore, necessitates round-the-clock shift work, and involves monitoring, control, and communication tasks of crucial importance to the safety and efficiency of production operations.

The research was undertaken by the University of Oxford with the co-operation and encouragement of several organizations:

- The work was commissioned by the Health Policy Division of the Health and Safety Executive, as part of its continuing programme of biomedical research. Publication of the research findings in the present form was funded by the Offshore Safety Division of the Health and Safety Executive.
- The research plan was developed following discussions with representatives of the United Kingdom Offshore Operators Association (UKOOA).
- BP Exploration, Aberdeen, agreed to facilitate access to the company's onshore and offshore installations, the research being carried out under the auspices of the BP Medical Department.

Without the co-operation of these organizations, the research described here would not have been possible; it is hoped that the findings will not only be of direct relevance to the organizations concerned, but will also serve to encourage greater awareness of the role of human factors research in the oil industry generally, and to stimulate further studies of the offshore environment in particular.
# CONTENTS

<table>
<thead>
<tr>
<th>PART 1</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>1.1 Mental health of offshore employees</td>
<td>1</td>
</tr>
<tr>
<td>1.2 Work and well-being among offshore employees</td>
<td>3</td>
</tr>
<tr>
<td>1.3 The present study</td>
<td>5</td>
</tr>
<tr>
<td>2. RESEARCH METHOD</td>
<td>6</td>
</tr>
<tr>
<td>2.1 Participants</td>
<td>6</td>
</tr>
<tr>
<td>2.2 Procedure</td>
<td>6</td>
</tr>
<tr>
<td>2.3 Measures</td>
<td>7</td>
</tr>
<tr>
<td>2.4 Data analysis and statistical methods</td>
<td>10</td>
</tr>
<tr>
<td>2.5 Presentation of the results</td>
<td>10</td>
</tr>
<tr>
<td>3. CHARACTERISTICS OF THE SAMPLE</td>
<td>12</td>
</tr>
<tr>
<td>3.1 Demographic factors, tenure, and shiftwork experience</td>
<td>12</td>
</tr>
<tr>
<td>3.2 Work preferences</td>
<td>12</td>
</tr>
<tr>
<td>4. HEALTH AND SLEEP PROBLEMS</td>
<td>13</td>
</tr>
<tr>
<td>4.1 Minor health complaints</td>
<td>13</td>
</tr>
<tr>
<td>4.2 Quality and duration of sleep</td>
<td>14</td>
</tr>
<tr>
<td>5. PERSONALITY AND MENTAL HEALTH</td>
<td>17</td>
</tr>
<tr>
<td>5.1 Personality characteristics</td>
<td>17</td>
</tr>
<tr>
<td>5.2 Mental health</td>
<td>17</td>
</tr>
<tr>
<td>5.3 Comparisons with published data</td>
<td>18</td>
</tr>
</tbody>
</table>
6. PERSONALITY AND OFFSHORE ADAPTATION 20
   6.1 Personality and environmental factors 20
   6.2 Type A, anxiety, and work satisfaction 20
   6.3 Personality and work preferences 27
   6.4 Personality and anxiety in relation to sleep 28

7. WORK PERCEPTIONS 31
   7.1 Measures 31
   7.2 Work perceptions in relation to location, job level and age 32
   7.3 Multivariate analyses of work perceptions and satisfaction 34
   7.4 Location, work perceptions, and anxiety 38
   7.5 Work perceptions and work satisfaction 40

8. DESCRIPTIVE ANALYSIS OF WORK CONCERNS 42
   8.1 Categories of problems reported 42
   8.2 Frequencies of problems reported 44
   8.3 Overview 45

9. CONCLUSIONS 46
   9.1 Mental health, onshore and offshore 46
   9.2 The role of Type A personality 47
   9.3 Type A and the offshore environment: practical issues 52
   9.4 Workload, neuroticism, job level, and anxiety 53
   9.5 Work perceptions, onshore and offshore 54

10 FURTHER WORK 58

PART II

1 INTRODUCTION 61
   1.1 Shifts, alertness, and control-room work 62

2. RESEARCH METHOD 65
   2.1 Participants 65
   2.2 Experimental design 66
   2.3 Experimental procedure 67
   2.4 Data analysis 68
SUMMARY

This report describes a two-part study of human factors, shift work and alertness in the oil industry, with particular reference to control-room personnel working offshore.

Part I reports a questionnaire survey of 172 control-room operators, employed either on North Sea platforms or at onshore terminals. The main aim of the study was to compare the onshore and offshore work environments, and assess their implications for employees' physical and mental health, work satisfaction, and sleep patterns. Age and personality factors were also examined in relation to these outcomes. The offshore group showed significantly higher anxiety than those working onshore; higher age, and personality traits reflecting impatience and time urgency, were jointly implicated in these elevated anxiety levels. A higher incidence of sleep problems, marked dissatisfaction with shift schedules, and higher perceived workload also characterized offshore employees as compared with those onshore. These findings are discussed with reference to the constraints and demands imposed by the offshore work environment.

Part II reports a smaller-scale, but more intensive, study of alertness among offshore operators in which subjective mood, and objective reasoning, memory, and reaction-time performance, were assessed repeatedly over the two-week offshore period, with particular reference to the effects of shift patterns and work hours. The results demonstrated significant fluctuations in alertness and performance over the course of the two-week offshore work cycle; effects associated with different times within shifts were particularly apparent, but different phases of the offshore cycle (night shifts, shift-change, and day shifts) also showed significant patterns of results. The most marked and adverse effects occurred during the shift-change phase. Factors influencing the scheduling of offshore shift work are discussed in relation to these findings, and further research in this area is suggested.
PART I

A survey of onshore and offshore control-room operators
1. INTRODUCTION

The work conditions of North Sea oil employees, and their lifestyle more generally, has attracted the attention of researchers from a number of disciplines, including occupational medicine, psychiatry, sociology, psychology, and physiology. Thus, the issues of health, safety, work characteristics, and psychosocial factors in the offshore environment have been addressed from a variety of different perspectives; however, several broad fields of interest can be identified.

These major areas include occupational health, safety, and the physical environment offshore, including lighting, noise and vibration (Cox, 1987; International Labour Office, 1980; Sunde, 1983); social networks, the lifestyles of oil employees and their families, the home-work interface, and the 'intermittent husband syndrome' (Clark et al. 1985; Lewis et al. 1988; Morrice, 1981; Morrice et al. 1985; Solheim, 1988; Taylor et al. 1985); psychosocial aspects of offshore work, including the perceived work environment, social support, personality, mental health and job satisfaction (Gann et al. 1990; Hellesoy, 1985; Sutherland & Cooper, 1986); and issues of ergonomics and work design (including shift patterns, work/rest schedules, confined work and living space, workplace layout, and task allocation), some aspects of which are reviewed by Sutherland and Cooper (1989).

Whilst all these areas of human factors research have some bearing on the present study, literature focusing on health, work perceptions, and psychosocial factors in the offshore environment is of particular relevance. Links between psychosocial work characteristics and levels of mental and physical health have been well-documented (e.g. Cohen et al. 1986; French et al. 1982; House, 1981; Karasek & Theorell, 1990); however, very little empirical research in this area relates specifically to the offshore environment. This is true in relation to each of the two main research questions which arise within this broad topic: first, whether levels of mental health among offshore workers are significantly different from those of comparable groups employed onshore; second, the extent to which conditions of work offshore are related to well-being and job satisfaction, and the personal and environmental factors which influence these relationships. The literature currently available is reviewed in the following sections.

1.1 MENTAL HEALTH OF OFFSHORE EMPLOYEES

Mental fitness is an important factor in pre-employment medical screening (Cox, 1987), not least because serious mental disturbance may necessitate medical evacuation (Normal et al. 1988). However, offshore workers may also experience less severe mental health problems, such as symptoms of anxiety and depression; whether such problems are more prevalent offshore than in comparable groups onshore merits research attention, particularly if offshore work conditions play a causal role in psychological distress.

To date, it appears that only two studies have attempted to compare the mental health of employees on North Sea installations in the UK sector with that of onshore groups. One study was based on questionnaire data obtained from employees of a 'major offshore personnel service company' (Sutherland & Cooper, 1986; Cooper & Sutherland, 1987). The other study was carried out more recently in a multi-national oil company (Gann et al. 1990). The authors of the two studies, using different methods, measures, and sample populations, came to different conclusions. Thus,
Sutherland and Cooper concluded that offshore workers had higher rates of anxiety and obsessional symptoms than comparable onshore groups, while Gann et al. found no difference between onshore and offshore employees in symptoms of anxiety and depression.

In view of the discrepancies in the findings, it is of interest to examine the basis of the conclusions reached in each of these studies. Sutherland and Cooper's data were collected by means of questionnaires mailed to potential respondents at their homes; the questionnaire included the Crown-Crisp Experiential Index (Crown & Crisp, 1979), a symptom checklist. As no comparison group of onshore employees was studied, the conclusion that free-floating anxiety and obsessionality were high relative to onshore groups was based on comparisons with 'normative' data taken from several different sources, including male General Practice patients, industrial males, and psycho-neurotic outpatients. A number of methodological aspects of this study need to be considered in assessing the validity of its findings.

- The response rate was very low; only 26% of those to whom questionnaires were sent returned usable data, raising questions as to the extent to which the sample was representative. Also, the data may have been influenced by cultural differences, as more than half the sample were from the Dutch sector.

- The conclusions about levels of anxiety and obsessionality were based on seemingly inappropriate comparison groups. In particular, both the industrial sample (age range 42-56 yrs.) and the General Practice sample (age range 35-70 yrs.) were considerably older than the offshore group (80% under 40 yrs.). Anxiety tends to decrease with age (Crisp et al. 1978); therefore, higher anxiety in the offshore group could be at least partially attributable to age.

- Two different methods of comparison with 'normative' data were used; results for anxiety were obtained by comparing mean values with one or other of the 'normative' groups (these comparisons did not show obsessionality to be high), and results for obsessionality were derived from examining the proportion of high scores in relation to those of neurotic patients (these comparisons did not show anxiety to be high).

These and other methodological weaknesses raise doubts as to the validity of the conclusions reached in Sutherland and Cooper's (1986) book. The more recent study by Gann et al. (1990) provides much-needed further information about relative symptom levels in onshore and offshore groups. Gann et al. administered anxiety and depression scales (Goldberg et al. 1988) to employees undergoing routine medical examinations. Both onshore and offshore personnel were included; there were 796 participants in the sample, representing an almost consecutive series of attenders.

The data were analysed with particular reference to job level, age, and the onshore/offshore comparison. At each job level, onshore/offshore differences failed to reach the .05 significance level for either anxiety or depression, with one exception (which would be expected from the number of significance tests carried out). The scope of Gann et al’s study was more limited than that of Sutherland and Cooper but the methodology was more rigorous, although the fact that medical examination was
compulsory for offshore employees but voluntary for those onshore raises some questions as to the comparability of the two groups. Also, data collection by company personnel in the context of a medical examination may have led to an under-reporting of symptoms among offshore employees, though concern that their continued employment might be jeopardized by adverse medical reports.

On the basis of these two studies, the view that offshore workers show less favourable mental health than their onshore counterparts is not well supported. However, even if significant differences were clearly demonstrated, their underlying causes could not be established without research into the psychosocial environment offshore and its implications for mental health. Indeed, it is inherently difficult to establish the direction of causal effects in works tress research. Nonetheless, studies which throw light on the nature of the stressors encountered in offshore work, and their associations with well-being, are potentially important.

1.2 WORK AND WELL-BEING AMONG OFFSHORE EMPLOYEES

Descriptive accounts of offshore work, including problems that may arise from the work environment itself and, more generally, from the lifestyle associated with offshore work have appeared in a number of publications (e.g. Cox, 1987; Solheim, 1988; Sunde, 1983). The potential sources of stress described include confined work and living conditions; lack of privacy; living in a mixed community of very different types of people; noise and other physical environment stressors, including potential hazards; shift patterns; dull and monotonous work in which periods of boredom are interspersed with periods of intense activity; and little opportunity for developing new skills.

The emphasis put on these different aspects of offshore work depends on the particular interests of the authors. For instance, Solheim (1988) writing from a sociological viewpoint, notes that the value of a job offshore is seen not to lie in the work itself, but in the release from it; thus, intrinsic job satisfaction is sacrificed in favour of external rewards of money and leisure at home. From a medical perspective, Sunde (1983) lists aspects of offshore work which may have adverse effects on health, but also notes features which may be more favourable. The latter include, in addition to enhanced pay rates and long periods of leave, careful monitoring of health, restrictions on smoking and alcohol, the availability of offshore health services, and a lower retirement age.

However, in spite of these potentially positive features, Cox (1987) suggests that “the offshore environment is still a rough and tough world, likely to tax the mental equilibrium of any person who is not wholly stable” (p.97). This raises the more specific issue of relations between work conditions, emotional stability, and the mental health of offshore employees. Surprisingly, in view of the extensive comment on this topic, little empirical research has been published which examines the impact of work conditions on the mental health and well-being of offshore personnel.

The major exception is a study carried out among personnel on the Statfjord platform in the Norwegian sector of the North Sea (Hellesoy, 1985). The Statfjord study surveyed several different occupational groups working on the platform (including contractors’ personnel and those employed directly by the operating company), using interviews and questionnaires. The main set of data (collected in 1980) was based on the questionnaire responses of some 450-500 individuals (numbers varied for
different questions), corresponding to response rates of approximately 64-71%. In addition, archival data (e.g., records of visits to the sick bay) were analysed.

In their report on this study, Hellesoy and his colleagues present many descriptive statistics, together with analyses linking perceptions of the work environment (including work characteristics, safety, hazards and risks, physical environmental factors, social support, and other aspects of the work situation) to self-reports of well-being including work satisfaction, physical health, and psychosomatic problems. These results are augmented by analyses of records maintained by the occupational health service (including frequency of contacts and diagnostic evaluation).

The Statfjord study adopted the 'Michigan model' of work stress (see, for instance, House, 1981) as a conceptual framework, and in this context particularly emphasized the role played by social support from supervisors and work group members in promoting safety, efficiency and well-being. Less attention was given to the role of individual differences, particularly in personality, which may also have a significant impact on relations between the work environment factors and outcome measures. Furthermore, as the study was cross-sectional (data being collected at a single point in time), no causal inferences could be made. Nonetheless, the research made a significant contribution to identifying potentially important psychosocial factors in the offshore work environment, and in documenting their associations with well-being.

In considering work conditions offshore and their implications for mental health, findings from the Sutherland and Cooper (1986) study noted earlier are also relevant. In addition to assessing mental health, these authors assessed job stressors (i.e., sources of stress in the job situation), work satisfaction, and personality traits, including Type A behaviour and locus of control (see page 9 for descriptions of these measures). Using these data, they examined between the perceived job stressors and symptom levels, and the extent to which the personality characteristics contributed to mental health independently of work conditions.

The authors concluded that poor relationships at home and at work were of major importance as predictors of dissatisfaction and distress, and that Type A behaviour merited further investigation in the context of offshore work. Whilst these conclusions are consistent with the more general work stress literature, methodological weaknesses may have given rise to empirical over-estimates of the magnitude and statistical significance of the relationships observed. In particular, problems of 'negative affectivity' (i.e., the tendency of some individuals to perceive themselves, their health, and their environment negatively) are ignored by Sutherland and Cooper. As Brief et al. (1988) demonstrate, negative affectivity inflates relations between self-reported stressors and well-being; such effects could account to a large extent for the correlations observed by Sutherland and Cooper. Several statistical limitations are also evident in the work, including the acceptance of unspecified 'near-significance' levels, and other technical problems, all of which tend to increase the chance of finding 'significant' relationships between work perceptions and measures of well-being.

### 1.3 THE PRESENT STUDY
Over the past decade, the technology of oil and gas extraction, the design of oil platforms, the regulations relating to offshore safety, and the economic climate in which the oil industry operates, have changed considerably. Thus, the extent to which the findings of the studies reviewed above reflect the current conditions and concerns of UK sector employees is uncertain. Moreover, many research questions which were not addressed (or not adequately resolved) by these earlier studies remain to be clarified.

The present survey attempted to overcome some of the limitations of earlier work, albeit in a relatively small-scale study. The main aims of the work were to compare measures of mental health, and perceptions of the work environment, in onshore and offshore groups; to identify the combinations of factors which characterize onshore and offshore work settings, and those associated with particular platforms and installations; to examine the roles played by work perceptions and personality in relationships between onshore/offshore environments and mental health; and to examine factors predictive of work satisfaction, including perceptions of workload and work-related social support.

The major features of the research approach adopted were as follows:

- Data were collected both onshore and offshore, thus allowing a more precise evaluation of the impact of offshore work conditions than is possible if research is carried out on among offshore personnel.

- The employees studied were control-room operators and other personnel carrying out similar tasks in the production areas. Whether located onshore or offshore, these operators are responsible for a variety of monitoring control, and communication tasks. Effective performance of these tasks is of critical importance to the production process; thus, the well-being and alertness of controllers is inherently of interest and concern. Furthermore, the present study allowed direct comparison between groups carrying out similar work onshore and offshore, an important methodological consideration.

- All data were collected on site, whether onshore or offshore, thus meeting the point made by Sutherland and Flin (1989) who noted that collecting data during leave periods (rather than in the work environment) may influence the responses obtained.

- The study was designed to obtain as high a response rate as realistically possible so as to avoid the inherent limitations of research in which many potential participants fail to respond.

- The questionnaire survey was carried out in the context of the wider program of research in which mood and alertness was repeated assessed in a sub-sample of the offshore operators over the course of particular work periods and particular shift sequences (see Part II of this report). Whilst the original intention was to carry out a pilot study with approximately 40 operators in the questionnaire survey and the assessment of mood and alertness, the survey was in fact extended to a much larger group.
2. RESEARCH METHOD

2.1 PARTICIPANTS

A total of 172 oil company personnel participated in the research. In the offshore group, there were 84 control-room operators (including some supervisors) drawn from three North Sea installations. For the purposes of this report, the installations involved were designated A1, A2 and A3. They differed in several respects. Thus, A1 had a complement of approximately 150 personnel, while A2 was large (200 personnel) and of more recent design and construction. The remaining participants were employed on A3; as compared with the other two installations, A3 was relatively small in size, and had more limited recreational facilities.

A comparison group of 88 operators and supervisors carrying out control-room tasks at six onshore sites (four located in Scotland, and two in North-East England) also took part. Data from two small sites were combined, and the five onshore locations are designated B1, B2, B3, B4, and B5.

All participants in this study were men; indeed, at the onshore and offshore installations involved, no women were employed as control-room operators. A high level of co-operation was received from those concerned; only 12 individuals declined to participate (including one entire shift team who made a collective decision not to be involved). In addition, data were missing for a few individuals who either could not be contacted because of long-term illness, or who were unable to complete the questionnaires while the experimenters were present and failed to return them by mail. Nonetheless, the overall data set included more than 90% of the intended sample.

Participants were operators who worked either in the control room or carried out similar control and monitoring tasks in the production areas, together with some of their supervisors. At some sites, the two different roles undertaken by operators were inter-changeable; operators could be assigned either to the control room or to the outside production areas during any particular duty period. Therefore, no distinction was made between the two roles in analysing the questionnaire data, although comparisons were made between supervisors and operators.

2.2 PROCEDURE

Prior to the start of data collection at a particular site, each potential participant received a personal letter from the researchers explaining the nature and purpose of the planned work. It was explained that, although the research was being conducted with the full co-operation and encouragement of the company, the work had been devised and proposed by the researchers, who would be responsible for carrying it out; it was also explained that questionnaires would be identified only by numbers, and that all individual data would be confidential to the research team.

Questionnaires were administered on site, either individually or in small groups, with an experimenter present; completion of the questionnaires (which took place during working hours, but away from the immediate workplace) required 45-60 minutes. Participants were encouraged to ask questions if any points were unclear, either about the research itself or about particular items. In a few instances, if individuals were willing to participate but could not attend to complete the questionnaires,
pre-paid envelopes were provided for postal return. Most of the data collection took place between July and December 1989, but some further questionnaire data were collected in March and in June 1990 to increase the sample size.

2.3 MEASURES

The questionnaires were divided into three main sections covering, respectively: general background information; personality and mental health; and perceptions of the work situation, and work satisfaction. Some items were written for the present study, but standard measures were used where available, particularly in the assessment of personality and well-being.

2.3.1 Demographic and background information

The first section included demographic information; present job level and tenure, and some details of previous employment; preference for onshore versus offshore work; ratings of sleep quality and duration when working different shifts; and, minor health problems (using the checklist devised by Vaernes et al., 1988).

2.3.2 Personality and mental health measures

The second section consisted of personality inventories assessing characteristics known to predict well-being and, more particularly, responses to work-related demands including shiftwork. Current mental health was assessed by means of a checklist of psychological symptoms. The main measures used are described below. In describing the personality measures, the traits associated with the ends of the scales are depicted, but the measures were scored on continuous dimensions.

- **Extraversion/introversion**: individuals high in extraversion tend to be sociable, lively, active, and out-going; in contrast, introverts are quieter, and more thoughtful, introspective and reserved. The measure used was an abbreviated version of the Eysenck Personality Questionnaire (Eysenck & Eysenck, 1975); in this short version (Eysenck et al. 1985), 12 items assessed extraversion.

- **Stability/neuroticism**: this dimension assessed the extent to which individuals are emotionally stable and resilient. Low neuroticism is associated with good coping skills, with favourable mental health, and with emotional stability and resistance to stress. Conversely, high scorers tend to cope less well with stressful circumstances; to be more emotionally unstable and prone to distress; and to take a generally negative view of themselves and their environment. The neuroticism measure formed part of the Eysenck Personality Questionnaire; in the version used (Eysenck et al. 1985), 12 dichotomous items (scored 0 or 1) assessed neuroticism.

- **Type a personality.** Individuals high in Type A personality traits tend to be competitive, hard-driving, achievement-oriented, impatient and time-pressured; this behavioural pattern, which is also characterized by a need for control over the environment, has been implicated in the development of cardiovascular disease. In contrast, Type B individuals are more easy going, patient and relaxed, and less competitive. The Framingham
Type A scale (Haynes et al., 1978), which has six items, was used to assess Type A behaviour.

- Analysing data from the Framingham scale, Houston et al. (1986) identified two factors ('Speed and Impatience', S-I, and 'Competitive Drive', C-D), which related differentially to anxiety and to cardiovascular reactivity. These two factors have also been observed in other studies of Type A behaviour (see, Powell, 1987), and were found to be replicated in the present data. In the work reported here, two orthogonal factors were derived (using principal components factor analysis followed by varimax rotation) from responses to the individual items of the Framingham scale. Factor scores were created for each individual on each of the two factors, and these scores were used as measures of the S-I and C-D components of Type A behaviour. This method of analysis allowed examination of whether the two components were differentially related to particular aspects of well-being in the sample as a whole, or among either offshore or onshore personnel.

- **Internal/external locus of control.** This dimension refers to the extent to which individuals believe that what happens to them in life depends on their own efforts, abilities and skills, as opposed to fate, chance, luck or powerful other people. In general, 'internals' tend to be more successful and satisfied at work, and to have better mental health than 'externals'. The measure used assessed locus of control specifically in relation to work situations (Spector, 1988); it had 16 items.

- **Diurnal type.** This questionnaire assesses individual differences in patterns of alertness over the course of the day which are relevant to adaptation to shift-work (Folkard, personal communication, 1989). The questionnaire has 10 items; the two poles of the dimension of assesses characterize 'morning types' (who are most alert and effective in the morning) and 'evening types' (who feel most alert and effective in the evening) respectively.

- **Mental health.** The measure of current symptom levels used was the 'General Health Questionnaire' (GHQ) (Goldberg, 1978), which has been validated against clinical ratings. The version used included a 12-item general scale of psychological symptoms, recommended for occupational and organizational research (Banks et al., 1980), and separate 7-item scales assessing somatic (physical) symptoms, anxiety, and social dysfunction (a measure of low morale), developed by Goldberg and Hillier (1979).

Banks et al. advocate Likert-scale scoring of GHQ responses, and this method was used here. Each item was scored on a 0-1-2-3 scale (higher scores representing greater distress) and sets of items were summed to form totals for each scale.
2.3.3 Assessment of the work environment and work satisfaction

This section of the questionnaire assessed perceptions of the work tasks and the work environment more generally; it also included measures of satisfaction with different aspects of the work situation, and two open-ended questions concerned with work-related demands and rewards. The measures analysed are described below.

- **Workload.** The scale used to assess workload focused on time pressures, quantitative work demand, and conflicting task demands. The 7 items on the scale were derived from large-scale survey data reported by Karasek (1979).

- **Discretion/autonomy.** This scale assesses the extent to which individuals perceive themselves as having some control over their work situation. The 7 items refer to participation in decision-making, control over work tasks, and opportunities for developing new skills; they were also derived from the work of Karasek (1979).

- **Job profile.** More detailed information about work characteristics was obtained using six items in which job situations representing opposite ends of particular job dimensions were described, and the respondent was asked to indicate the position of his job on each scale (Caplan et al. 1975). Factor analysis revealed that the six items assessed two separate aspects of the work situation: first, the extent to which the work involved pre-determined task carried out according to a fixed routine; and second, the extent to which the job involved concentration, interaction with other workers, a need for flexibility in meeting multiple task demands, and a varying pace of work. The first scale was labelled 'monotony', and the second 'complexity'.

- **Social support.** Scales assessing social support at work were taken from House (1981). The items assess the extent to which supervisors and colleagues are supportive and helpful in relation to day-to-day problems at work. Further items assess work-related support from spouse and family. The 10 items were scored to provide three measures: supervisor support, support within the workgroup, and spouse/family support.

- **Work Satisfaction.** A total of 17 items assessed various aspects of work satisfaction, including satisfaction with pay, hours of work and shifts, physical working conditions, skill and variety in tasks, status and perceived importance of the job, and with the management and people in the organization. Factor analysis of responses to these items identified three main dimensions: general satisfaction (7 items), organizational satisfaction (3 items, concerned with satisfaction with management, people, and physical working conditions), and status satisfaction (3 items relating to the extent to which supervisor, other workgroup members, and the individual himself perceived the job as important). The remaining four items did not fall clearly on any of the three scales; two of them (satisfaction with pay, and satisfaction with working hours and shift patterns) were treated as individual items, and the two less important items were disregarded.

2.3.4 Scale reliabilities
Several work environment measures were constructed by summing items to form scale scores on the basis of factor analysis results. To assess the extent to which the items assigned to particular scales formed coherent measures, internal consistencies were calculated for each of the scales concerned. These 'coefficient alpha' values were found to be well within acceptable limits: general satisfaction, 89; organizational satisfaction, 68; status satisfaction, 77; complexity, 74.

2.4 DATA ANALYSIS AND STATISTICAL METHODS

Data analysis was carried out by computer, using SPSSX (Nie, 1983) and other statistical programs. In general, the data set was very complete; most analyses were based on N=172 (the full sample size), although in some cases the sample size was reduced to 168-170 by missing data. The statistical methods used included simple tests such as chi-square for testing differences in the frequencies of responses in different categories; t-tests or F tests for comparing the means of continuous variables in different groups; and the use of correlations to examine relations between pairs of continuous variables.

However, the nature of the data and the issues addressed also necessitated use of more complex multivariate statistical techniques. These methods allow examination of the relative contributions of several variables which jointly predict a particular outcome or 'dependent' measure. The multivariate methods used included multiple regression, analysis of variance and covariance, and discriminant analysis; choice of one or other of these techniques depends on the nature of the predictor variables and the dependent variables (particularly whether they are categories, such as onshore/offshore location, or continuous scores such as anxiety) and the purpose of the analysis. In the multivariate analyses, mean values were substituted for the occasional missing data points so as to retain the complete data set.

2.5 PRESENTATION OF THE RESULTS

In presenting the results, overall comparisons between onshore and offshore personnel (on demographic factors, onshore versus offshore work preferences, health complaints and sleep reports, mental health and work satisfaction) are described first. The role of personality in adaptation to offshore work is then considered, with particular reference to neuroticism and Type A. Subsequent sections examine perceptions of work tasks and the onshore and offshore work environment, and the combined effects of personality and work perceptions in predicting anxiety. Finally, Section 8 reports a descriptive analysis of the views and concerns of control-room personnel.
3. CHARACTERISTICS OF THE SAMPLE

The initial analyses examined differences between the onshore and offshore groups in demographic characteristics and other background measures, including preferences for onshore versus offshore work. In addition, differences between groups working at different locations within the offshore environment (A1, A2, and A3) and the onshore environment (B1, B2, B3, B4, B5) were examined.

3.1 DEMOGRAPHIC FACTORS, TENURE, AND SHIFTWORK EXPERIENCE

There were few demographic differences between the onshore and offshore groups. The main exception was age; onshore employees were significantly older (average, 44.5 years) than their offshore counterparts (average, 40.9 years). Within the onshore and offshore groups, there were also significant age differences between those working on different installations. For the offshore employees, the average length of employment in their present jobs was nearly 7 years, while for those onshore it was about a year less. The great majority of respondents (87%) had been employed on shiftwork prior to their present job; on average, respondents had a total of more than 18 years experience of shift work. Further details of age, tenure in present job, and number of years experience of shiftwork are shown in Table 3.1.1.

<table>
<thead>
<tr>
<th>Location</th>
<th>Average age (years)</th>
<th>Average years in present job</th>
<th>Average years of shiftwork</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>42.0</td>
<td>6.7</td>
<td>18.8</td>
</tr>
<tr>
<td>A2</td>
<td>37.4</td>
<td>7.1</td>
<td>15.4</td>
</tr>
<tr>
<td>A3</td>
<td>44.1</td>
<td>6.8</td>
<td>21.4</td>
</tr>
<tr>
<td>Offshore</td>
<td>40.9</td>
<td>6.9</td>
<td>18.2</td>
</tr>
<tr>
<td>B1</td>
<td>42.4</td>
<td>8.0</td>
<td>18.4</td>
</tr>
<tr>
<td>B2</td>
<td>47.3</td>
<td>6.2</td>
<td>23.4</td>
</tr>
<tr>
<td>B3</td>
<td>46.6</td>
<td>7.7</td>
<td>20.0</td>
</tr>
<tr>
<td>B4</td>
<td>43.2</td>
<td>2.5</td>
<td>17.8</td>
</tr>
<tr>
<td>B5</td>
<td>43.1</td>
<td>5.0</td>
<td>18.5</td>
</tr>
<tr>
<td>Onshore</td>
<td>44.5</td>
<td>5.7</td>
<td>19.3</td>
</tr>
</tbody>
</table>

3.2 WORK PREFERENCE

Preference for working onshore or offshore was assessed on a five-point scale, ranging from 'definitely prefer onshore' through 'no preference' to 'definitely prefer offshore'. There was a highly significant difference between the onshore and offshore groups in these preference ratings (Mann-Whitney test, $U = 2346.5$, $Z = 4.30$, $p < 0.001$).
Very few of the onshore group (5.7%) expressed any preference for working offshore. The responses of the offshore personnel were more ambivalent; 48.8% of the respondents indicated that they would prefer to work onshore, 17.9% were neutral, while 33.3% expressed a preference for offshore work. The distributions of the preference responses for the onshore and offshore groups are shown graphically in Figure 3.2.1.

The main reasons given by offshore employees for not working onshore were lack of employment opportunities near their homes, and pay rates. More positively, offshore respondents valued the relatively long leave periods spent with their families. In spite of their ambivalence about offshore work, offshore personnel appeared to be a very stable workforce; almost all respondents thought that they would still be in the same job in a year's time. In the onshore group, 91% expected to stay in their jobs.

![Figure 3.2.1](image)

**Figure 3.2.1**
Preferences for onshore versus offshore work in the onshore and offshore groups
4. HEALTH AND SLEEP PROBLEMS

4.1 MINOR HEALTH COMPLAINTS

Reports of minor health complaints experienced during work periods in the previous 6 weeks (including headaches, neck pain, shoulder pain, back pain, indigestion, heartburn, stomach upset) were assessed with a checklist previously used in a study of process-control workers in the Norwegian chemical industry (Vaernes et al. 1988). In general, the present findings are similar to those reported by Vaernes et al. The main results from the analyses are summarized in Table 4.1.1.

Table 4.1.1
Percentages of onshore and offshore groups reporting minor health problems

<table>
<thead>
<tr>
<th></th>
<th>Onshore</th>
<th>Offshore</th>
<th>Significance of difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headaches</td>
<td>34%</td>
<td>43%</td>
<td>ns</td>
</tr>
<tr>
<td>Sleep problems</td>
<td>36%</td>
<td>54%</td>
<td>p &lt;.04</td>
</tr>
<tr>
<td>One or more of the other minor problems</td>
<td>67%</td>
<td>54%</td>
<td>(p = .11)</td>
</tr>
</tbody>
</table>

- With the exception of concerns about sleep, headaches were the most frequently reported health problems. Thus, 42.8% of the offshore group and 34.4% of the onshore group reported headaches; the difference between these rates was not significant. However, of those who did endorse the headache item, onshore personnel were more likely to report moderate or severe headache problems whereas, among offshore respondents, mild problems were more commonly reported.

- Sleep problems were reported by nearly half the respondents overall, but the distribution of responses was significantly different for onshore and offshore groups (chi-square = 4.59, df=1, p=.032). Both mild and moderate problems were more frequently reported by offshore personnel (54%) as compared with those working onshore (36%). In contrast, only 24.7% of the sample of onshore shift-workers in the Vaernes et al. (1988) study reported sleep problems.

- Each of the other health complaints included in the checklist were reported by less than 25% of respondents. When responses in these minor categories were summed, it was found that the onshore group was more likely to report problems than the offshore group (66.7% as compared with 53.6%). This difference did not reach the .05 significance level, but its direction is consistent with the higher medical standards required of offshore employees, and with their younger average age.

- There was a highly significant relationship between high neuroticism scores and reports of health problems. This was particularly evident in relation to reports of headaches, but was also apparent in reports of other health
problems, as shown in Table 4.1.2. There was no difference between the onshore and offshore groups in this respect.

Table 4.1.2
Neuroticism in relation to reported health problems

<table>
<thead>
<tr>
<th>Problem reported</th>
<th>Problem not reported</th>
<th>Significance of difference in neuroticism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headaches</td>
<td>4.17 (n=66)</td>
<td>2.67 (n=105)</td>
</tr>
<tr>
<td>Sleep problems</td>
<td>4.03 (n=76)</td>
<td>2.62 (n=94)</td>
</tr>
<tr>
<td>At least one of the other minor health problems</td>
<td>3.65 (n=103)</td>
<td>2.63 (n=68)</td>
</tr>
</tbody>
</table>

1 Neuroticism scores ranged from 0 to 12, higher scores indicating a higher level of neuroticism.

4.2 QUALITY AND DURATION OF SLEEP

More detailed information about sleep quality and duration was also obtained in the present study. Respondents were asked to report mean sleep duration (in hours), and to rate sleep quality on a 0 - 6 scale ranging from 'very badly' to 'very well'. Both questions were asked in relation to sleep periods when working (i) day shifts, (ii) night shifts, and (iii) when on leave.

4.2.1 Data analysis

Analysis of variance was used to examine the data relating to sleep quality and duration; the factors in these analyses were onshore/offshore location (tested 'between groups'), and day/night shifts (tested 'within subjects'). Data relating to leave periods were treated as covariates in the onshore/offshore comparisons to control for the possibility that there might be differences in sleep patterns between the onshore and offshore groups which were unrelated to shift schedules.

4.2.2 Results

The main findings from these analyses were as follows:

- Sleep quality. Overall, reported sleep quality was significantly higher onshore than offshore (p<.05). However, this overall difference obscured a highly significant interaction (p<.0001) between onshore/offshore location and day/night shifts in predicting sleep quality. Onshore, sleep quality
ratings were more favourable (4.28) for day-shift work than for night-shift work (3.23). In contrast, the opposite pattern was reported by offshore personnel; sleep quality ratings were higher (3.63) for night-shift work than for day-shift work (3.17). The data are shown graphically in Figure 4.2.1.

![Figure 4.2.1](image)

Sleep quality ratings onshore and offshore for day and night shifts

- **Sleep duration.** Both location and day/night shifts showed overall effects on reported sleep duration; however, the most highly significant effect was the interaction between these two factors (p<.0001). The data are shown graphically in Figure 4.2.2. In the onshore group, reported sleep duration was longer for day-shift work (7.10 hours) than for night-shift work (5.89 hours). These data are similar to those of Tilley *et al.* (1982), and represent a cumulative sleep loss of 7-8 hrs over a week of night shifts. For the offshore groups, the difference in reported sleep duration for day versus night work was not large (6.97 and 7.18 hours, respectively), but it was in the opposite direction to that for the onshore group. Thus, the sleep pattern of offshore workers is different from the normal pattern of day/night shift sleep hours for onshore workers, and suggests that the 'round-the-clock' environment which operates offshore may facilitate adaptation to night work. Factors which may contribute to these findings are discussed by Parkes (1992a), and outlined in Part II of this report (see page 90).
Sleep duration onshore and offshore for day and night shifts

- **Sleep quality and duration during leave periods.** There were no significant difference between onshore and offshore personnel in reported sleep duration (mean hours = 7.66 hours) or quality (mean rating = 4.78) while on leave; thus, there was no evidence to suggest long-standing differences in sleep patterns between the two groups.

- **Sleep difference within the onshore and offshore groups.** There were no differences between the five onshore installations in reported sleep quality or duration for either day shifts or night shifts. The same was true of the offshore locations (A1, A2, and A3), with the exception of a tendency (p=.06) for the duration of night-shift sleep to differ across the three installations. The highest value was reported by personnel on A2 (7.6 hours) and the lowest for those on A1 (6.8 hours). This finding can most probably be attributed to the more recent design of installation A2 (providing a higher standard of accommodation, and greater separation of production and accommodation areas) as compared with installation A1.

- **Sleep quality and duration in relation to age.** Reported duration of sleep was significantly related to age; thus, relative to the sleep hours reported during leave periods, older employees reported significantly less sleep than younger ones during periods of shiftwork. This was true of sleep during day-shift periods (p<.05) and, to a much greater extent, during night shifts (p<.001).

Further analyses of the sleep measures, in which the roles of individual differences in personality and background factors are examined using multivariate methods, are reported in Section 6.4.
5. PERSONALITY AND MENTAL HEALTH

5.1 PERSONALITY CHARACTERISTICS

The initial analyses of the personality examined overall differences in personality between the onshore and offshore groups, and compared data for the present sample with published data for male population groups. The main findings from these analyses were:

- There were no significant differences between onshore and offshore groups in any of the individual personality traits assessed (including neuroticism, Type A personality, introversion/extraversion, locus of control, and diurnal type).

- There were no significant differences in personality measures between Groups A1, A2, A3 of the offshore sample, or between Groups B1, B2, B3, B4, and B5 of the onshore sample.

5.2 MENTAL HEALTH

In analysing data from the General Health Questionnaire, the onshore and offshore groups were compared in terms of scores on the GHQ-12 (a measure of general mental health), and on the scales assessing anxiety, somatic symptoms, and social dysfunction. In addition, the GHQ-12 scores were compared with published data, although for the other scales no suitable published data were available. The main findings are outlined in the following paragraphs, and the mean scores for the GHQ-12 and the GHQ Anxiety measures are shown in Table 5.2.1, together with normative GHQ-12 data published by Banks et al. (1980).

- There were no significant differences between the onshore and offshore groups in somatic symptoms or social dysfunction scores. For both measures, onshore and offshore values were closely similar.

- There was a highly significant difference between the onshore and offshore groups in scores on the GHQ Anxiety scale; the mean value for the offshore group (3.62) was markedly higher than that for the onshore group (2.43).

- The GHQ-12 scores also showed significant differences between the onshore and offshore groups. Again, mean scores were higher for the offshore group (8.75) than for the onshore group (7.64). However, the GHQ-12 score reflects general mental health, and thus includes a number of questions specifically concerned with symptoms of anxiety; covariance analysis indicated that the significance of the difference between mean GHQ-12 scores for the onshore and offshore groups could be almost entirely ascribed to the anxiety component, rather than to other types of symptoms.
Table 5.2.1
Mental health measures: GHQ-12 and GHQ Anxiety scores

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean GHQ-12 score</th>
<th>s.d</th>
<th>Mean GHQ Anxiety score</th>
<th>s.d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total sample</td>
<td>172</td>
<td>8.18</td>
<td>3.40</td>
<td>3.01</td>
<td>2.90</td>
</tr>
<tr>
<td>Onshore group</td>
<td>88</td>
<td>7.64(^1)</td>
<td>2.94</td>
<td>2.43(^2)</td>
<td>2.18</td>
</tr>
<tr>
<td>Offshore group</td>
<td>84</td>
<td>8.75</td>
<td>3.76</td>
<td>3.62</td>
<td>3.42</td>
</tr>
<tr>
<td>Published data(^3)</td>
<td>552</td>
<td>8.80</td>
<td>4.02</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

Details of the GHQ scales and scoring method are given on page 9.

\(^1\) This value is significantly different \((t=3.25, p<.01)\) from the published value, and significantly different \((t=2.17, p<.05)\) from the corresponding value for the offshore group.

\(^2\) This value is significantly different \((t=2.73, p<.01)\) from the corresponding value for the offshore group.

\(^3\) The values are taken from data published by Banks et al. (1980).

5.3 COMPARISONS WITH PUBLISHED DATA

5.3.1 Personality measures

As far as could be determined from the available literature, personality scores among the onshore and offshore personnel studied were generally similar to those of male respondents in the population as a whole. However, as shown in Figure 5.3.1, the present sample was significantly lower in neuroticism \((p<.01)\) and higher in extraversion \((p<.05)\) than the population norms given by Eysenck et al. (1985). This combination of low neuroticism and high extraversion (reflecting a tendency to be sociable, active, emotionally resilient, and adaptable) is associated with better-than-average mental health. Thus, on this basis, it would not be expected that the present sample would show high average levels of psychological symptoms whether they worked onshore or offshore. Indeed, relative to the general population, below-average symptom levels would be predicted.
5.3.2 Mental health measures

Scores on the GHQ-12 measures were examined in relation to published data for a stratified sample of 552 males working in an engineering plant (Banks et al. 1980). The overall mean GHQ-12 score for the present group was 8.18, whereas the corresponding published value was 8.80.

As GHQ-12 scores differed significantly for the onshore and offshore groups, comparison with the published value was also carried out separately for the two groups. Onshore, the mean GHQ-12 score was significantly lower than that of the comparison group, while offshore the mean value was closely similar to that of the comparison group (see Table 5.2.1 in Section 5.2).

The GHQ-12 data reported by Banks et al. were obtained from a group broadly comparable to the present sample in occupational and demographic characteristics. Direct comparisons with published data must be always interpreted with caution: nonetheless, it is worth noting that the findings for the onshore group are in accordance with the expectation that the personality characteristics of the present sample should predispose them to relatively good mental health, whereas the offshore group (with similar personality characteristics) did not show this expected pattern.

A more detailed account of the comparison of mental health levels in the onshore and offshore groups, and their relationship to normative data, has been published elsewhere (Parkes, 1992b).
6. PERSONALITY AND OFFSHORE ADAPTATION

6.1 PERSONALITY AND ENVIRONMENTAL FACTORS

Taken together, the results described in Section 5.2 suggest a specific association between reported anxiety symptoms and offshore work. This finding was not attributable to age differences between the onshore and offshore groups (it remained significant when age was taken into account; nor could it be ascribed to general negative responding on the part of offshore workers, as it was not observed for the other symptom measures. Furthermore, the two groups showed similar mean scores on relevant personality measures.

Personality may nonetheless explain some of the observed variance in measures of mental health and work satisfaction. Two different mechanisms are possible. First, personality and environmental factors may contribute independently to health outcomes; in this case, each factor makes a unique contribution, and the overall result reflects the sum of the separate effects. Alternatively, personality characteristics may combine interactively with certain environmental factors. In this case, adverse outcomes are observed only when individuals high in the relevant personality trait are exposed to the particular environmental features concerned. Interaction effects of this kind are familiar in the stress literature, and Hellesøy (1985) notes the importance of person-environment interaction in relation to offshore work. More specifically, Cooper and Sutherland (1987) draw attention to the potential role of Type A personality in this context.

6.2 TYPE A, ANXIETY, AND WORK SATISFACTION

The possibility that the higher anxiety observed among the offshore group might be explained by an interaction between personality and the offshore environment was examined with particular reference to the Type A personality measure. The general prediction was that Type A personality would be more measure. The general prediction was that Type A personality would be more strongly related to adverse mental health outcomes among those working in the offshore environment than among the onshore personnel. However, Type A is not a single construct; in the measure used in the present work, psychometric studies have identified two different components, 'Speed and Impatience' (S-I) and 'Competitive Drive' (C-D). Moreover, research by Houston et al. (1986) links anxiety specifically to the S-I component; therefore, a more definite prediction was made that this component would be implicated in anxiety among offshore employees. Conversely, Feather and Volkmer (1991) report data suggesting that the C-D component of Type A is related to a preference for tasks involving effort and challenge, leading to the prediction that the C-D component would be particularly relevant to work satisfaction offshore.

Moderated multiple regression (see, for instance, Cohen & Cohen, 1983) was used to test interactions between the Type A components and onshore/offshore location in predicting anxiety and work satisfaction. This method of analysis does not necessitated arbitrarily dividing the sample into 'high' and 'low' Type A sub-groups; instead, regression methods allow a more precise approach in which the S-I and C-D Type A scores are treated as continuous scales. In each analysis, the independent variables were entered hierarchically into the regression model. In order to control for other possible influences on outcome, the model included demographic factors, job level (supervisor/operator), and neutroticism (thus controlling for general...
negative responding), in addition to location (onshore/offshore) and the two Type A components, S-I and C-D. As anxiety and satisfaction were not orthogonal \((r=.13)\), each was treated as an initial covariate in the analysis of the other, thus controlling for shared variance. Variables were entered in a pre-determined order, the interaction terms (location x S-I, and location x C-D) being tested in the final step.

6.2.1 'Speed and Impatience' in relation to anxiety

The regression analysis of anxiety scores (square-root transformed to normalize the distribution) is shown in Table 6.2.1. The initial stages of the analysis confirmed the higher overall level of anxiety among offshore personnel as compared with those onshore. Other factors positively predictive of anxiety were higher job level, neuroticism, and S-I scores. More importantly, the final stage of the analysis demonstrated a significant interaction between onshore/offshore location and S-I Type A scores. In the offshore group, S-I scores and GHQ Anxiety were significantly related; in contrast, for the onshore group the relationship was non-significant \((F<1)\).

<table>
<thead>
<tr>
<th>Source</th>
<th>(R^2)</th>
<th>(t)</th>
<th>(P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariate</td>
<td>.016</td>
<td>-1.64</td>
<td>ns</td>
</tr>
<tr>
<td>+ Age</td>
<td></td>
<td>&lt;1</td>
<td>ns</td>
</tr>
<tr>
<td>+ Job level</td>
<td>.068</td>
<td>2.03</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>+ Onshore/offshore</td>
<td>.327</td>
<td>7.94</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>+ Neuroticism</td>
<td>.350</td>
<td>1.99</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>+ Location x S-I</td>
<td>.370</td>
<td>2.27</td>
<td>&lt;.025</td>
</tr>
</tbody>
</table>

Overall model: \(F (8,161) = 11.8, p<.0001\)

The form of the interaction between S-I scores and onshore/offshore location in predicting anxiety is shown graphically in Figure 6.2.1. Among offshore personnel, anxiety levels are directly related to S-I scores; the high mean anxiety scores in the this group are very largely attributable to individuals above-average in S-I personality traits. In contrast, among the onshore personnel, anxiety scores are unrelated to S-I traits and tend to be relatively low (comparable in magnitude to those of low S-I offshore personnel). Thus, the person-environment interaction effect is
such that elevated anxiety levels are found only among offshore personnel high in S-I traits.

Figure 6.2.1
The relationship between S-I Type A scores and anxiety among onshore and offshore personnel
Further analyses of Type A scores in relation to anxiety revealed that:

- The interactive pattern was consistent across the different onshore and offshore locations, and therefore could not be attributed to particular features of individual installations.

- The interaction between onshore/offshore location and S-I scores was not significant for any of the other GHQ scales; it was specific to anxiety.

- The 'Competitive Drive' (C-D) component of Type A behaviour did not interact significantly with onshore/offshore location in predicting anxiety.

### 6.2.2 The combined roles of age and S-I scores in predicting anxiety among offshore employees

The increasing age profile of offshore employees (a natural outcome of the industry itself becoming more mature) is currently a source of concern in operating companies, particularly as the demands of offshore work may impact more severely on older individuals than on their younger counterparts. This issue was raised by Hellesoy (1985) who noted that the problems of older employees working offshore merited special attention. In the present data, overall, age was not significantly related to anxiety, or to either of the Type A components. However, it was of interest to examine whether age accentuated relationships between Type A scores and anxiety among offshore personnel.

Further analyses were carried out to address this issue. Specifically, the model was extended to test whether age influenced the form of the interaction between location and S-I Type A scores. The three-way interaction (location x S-I x age) was found to be significant (p<.025); thus, the relationship between S-I scores and anxiety depended not only on onshore versus offshore location but also on age. Further examination revealed that age influenced relations between S-I scores and anxiety in the offshore group but showed no similar interactive effects in the onshore group.

The relationships between S-I Type A scores and anxiety for offshore employees at three different ages (35 years, 42 years, and 50 years) are shown in Figure 6.2.2. The 35-50 years age range includes approximately 70% of the offshore population studied, less than 10% of the group being older than 50 years. It can be seen that, as age increases, the relationship between S-I scores and anxiety among offshore workers becomes more marked; thus, offshore employees towards the higher end of the age distribution who are also high in S-I traits report the highest levels of anxiety. No similar patterns were observed in the onshore group.

The particular ages represented in Figure 6.2.2 were arbitrarily chosen to illustrate findings for younger, average, and older offshore workers. However, the gradient of the line relating S-I scores to anxiety increases progressively with age among offshore workers. Thus, in principle, a separate regression line could be drawn for each age, reflecting the fact that the ageing process is one of gradual change, rather than sudden discontinuity.
Figure 6.2.2.
The Relationship between S-I Type A scores and anxiety for offshore personnel at different ages

'Speed and Impatience' Type A score
Scores on both scales are standardised to a mean of zero and unit standard deviation
Further analyses of the anxiety data revealed a significant curvilinearity in the overall age effects. In the sample as a whole, both older and (to a lesser extent) younger ages were associated with an increase in anxiety relative to mean age levels (see Figure 6.2.3). It is possible that more limited experience of control-room work tended to give rise to the higher anxiety observed among younger employees, irrespective of whether they worked onshore or offshore; however, as can be seen in Figure 6.2.3, the high anxiety reported by offshore employees who were above-average in age (particularly those aged 50 years and above), and who were also high in S-I Type A traits, remained the most conspicuous feature of the findings.

![Figure 6.2.3](image)

**Figure 6.2.3**
Age, S-I Type A scores, and onshore/offshore location as predictors of anxiety: Curvilinear trends

6.2.3 'Competitive Drive' in relation to work satisfaction
The analysis described in Section 6.2.1 was repeated using general work satisfaction as the outcome measure. In this analysis, particular attention was given to the 'Competitive Drive' (C-D) component of Type A personality, and its predicted interaction with onshore/offshore location. The regression analysis is shown in Table 6.2.2; job level was found to be a significant predictor of satisfaction (supervisors reporting higher levels than operators), while high neuroticism was associated with low levels of satisfaction.

<table>
<thead>
<tr>
<th>Source</th>
<th>R²</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariate</td>
<td>.016</td>
<td>-1.64</td>
<td>ns</td>
</tr>
<tr>
<td>+ Age</td>
<td></td>
<td>1.61</td>
<td>ns</td>
</tr>
<tr>
<td>Job level</td>
<td></td>
<td>2.42</td>
<td>&lt;.025</td>
</tr>
<tr>
<td>Onshore/offshore</td>
<td>.069</td>
<td>&lt;1</td>
<td>ns</td>
</tr>
<tr>
<td>+ Neuroticism</td>
<td>.112</td>
<td>-2.82</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>+ S-I Type A</td>
<td></td>
<td>&lt;1</td>
<td>ns</td>
</tr>
<tr>
<td>C-D Type A</td>
<td>.134</td>
<td>1.81</td>
<td>ns</td>
</tr>
<tr>
<td>+ Location x S-I</td>
<td>.171</td>
<td>2.67</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Location x C-D</td>
<td></td>
<td></td>
<td>Non-significant</td>
</tr>
</tbody>
</table>

Overall model: F (8,161) = 4.14, p<.0002

Overall, the onshore and offshore groups did not differ significantly in satisfaction; however, the final stage of the regression analysis showed that C-D scores interacted with onshore/offshore location. Thus, the relationship between C-D scores and satisfaction differed significantly in the onshore and offshore groups. In the onshore group, work satisfaction was unrelated to C-D scores; in contrast, in the offshore group, higher C-D scores were significantly related to higher satisfaction. The form of the interaction is illustrated in Figure 6.2.4. It can be seen that, although there is no overall difference in satisfaction between onshore and offshore employees, individuals who are high in C-D traits (i.e. who are achievement-oriented and ambitious) report higher satisfaction if they work offshore than if they work onshore; conversely, those who are low in C-D traits report higher satisfaction if they work onshore than if they work offshore. Thus, as predicted, the C-D component of Type A personality has significant implications for satisfaction in the offshore work setting, but not in the onshore environment.
Further analyses showed that the S-I component on Type A was not implicated in work satisfaction, either onshore or offshore. There were also no effects of age comparable to those reported in Section 6.2.2 for S-I scores and anxiety among offshore personnel.

**6.3 PERSONALITY AND WORK PREFERENCES**

In view of the importance of personality variables in relation to offshore work adaptation, the personality traits assessed were also examined as predictors of reported preferences for offshore versus onshore work. As described below, the results showed that personality played a significant role in relation to onshore/offshore work preferences.
6.3.1 Data analysis

The analyses were complicated by the fact that scores on the preference measure, particularly for the onshore group, were strongly biased towards the high end of the scale, indicating a general preference for onshore work (see Section 3.2). This skewed distribution limited the statistical methods which could be used to examine the data. However, analyses in which the five preference ratings were treated as categories, and personality measures were treated as the dependent variables, with age as a covariate, yielded a number of significant findings.

6.3.2 Results

The main findings obtained from the analysis of work preferences in relation to personality can be summarized as follows:

- In the sample as a whole, two personality characteristics were significantly related to preference ratings; personnel reporting greater preference for working offshore were significantly higher in extraversion, and in the C-D component of Type A personality, than those who reported a greater preference for working onshore. These effects remained significant after control for age differences between the two groups.

- Relationships between preference for working offshore and personality (extraversion, and C-D Type A) tended to be more marked in the onshore group (relatively few of whom expressed a preference for working offshore) than in the offshore group. These findings are of particular interest as they may indicate the extent to which personality plays a role in the decision to seek offshore work among those currently working onshore.

- In the offshore group, there was no relationship between age and preference ratings; however, in the onshore group younger individuals were more likely to report a preference for working offshore. This interaction effect was marginally significant (p<.07).

- There was no significant relationship between preference ratings and GHQ Anxiety scores in the offshore group. This was also true of the onshore group; thus, there was no evidence to suggest that high anxiety predisposes onshore employees to seek offshore work.

The results outlined above suggest that the sociable and active lifestyle characteristic of extraverts, and the ambitious and competitive aspects of the Type A personality may lead individuals to seek work offshore, and (as noted above in the analysis of the C-D component of Type A) to find greater satisfaction in the opportunities afforded by offshore work.

6.4 PERSONALITY AND ANXIETY IN RELATION TO SLEEP

The results presented in Section 4.2 demonstrated that reported sleep quality and duration were significantly different for day and night shifts, and that the nature and extent of these differences depended on onshore versus offshore location. However, as described below, both personality and anxiety also played a significant role in
relation to sleep measures; in general, these effects were independent of those associated with location.

### 6.4.1 Data analysis

Several personality traits, including neuroticism, were significantly correlated with the duration and/or quality of sleep during work periods, especially night shifts. The measures primarily involved were the diurnal type scale, the S-I component of Type A, together with the GHQ Anxiety scale. Regression analyses were used to examine these relationships further.

### 6.4.2 Correlational findings

- **Night shifts: sleep quality.** Scores on the S-I Type A measure and the GHQ Anxiety scale significantly predicted sleep quality during night-shift work; each made an independent contribution to the variance in sleep quality, over and above the contributions of location, and of sleep quality during leave periods. Poor sleep quality was associated with high GHQ Anxiety scores (p<.002) and with high S-I Type A scores (p<.04).

- **Night shifts: sleep duration.** Reported sleep duration when working night shifts was predicted by neuroticism (p<.01). High neuroticism was associated with shorter sleep duration, after control for sleep duration during leave periods.

- **Day shifts.** In general, sleep quality and duration while working day shifts showed only weak relationships with personality variables. However, anxiety was a significant predictor of sleep quality (p<.002) over and above location and the other sleep measures; higher anxiety was associated with poorer sleep quality.

- **Sleep measures and satisfaction with shift schedules.** Further analyses were carried out in which two sleep quality measures (the average of the day and night shiftwork ratings, and the leave rating) were examined in relation to reported satisfaction with shift schedules. The results showed that the difference between sleep quality at home and average sleep quality during work cycles significantly predicted dissatisfaction with shift patterns (p<.001). Thus, the better the sleep quality while on leave, and the worse it was during the work cycle, the greater the dissatisfaction with shift schedules. The same pattern was found for sleep duration (p<.01). Over and above these effects, shift schedule dissatisfaction was greater offshore than onshore.

### 6.4.3 Further analyses

A more detailed multivariate analysis of sleep quality and duration in the present sample was also carried out. In this analysis, two different shift patterns in operation onshore (weekly rotation, and 'fast rotation' in which only two or three consecutive night shifts are worked) were compared with the weekly-rotation pattern operating offshore. Age, cumulative number of years of shiftwork, and neuroticism were also included in the analyses. Repeated-measures analysis of variance methods were used; sleep duration and quality for day-shift and night-shift periods, and during
leave, were the dependent variables. The results confirmed the longer night-shift sleep duration, and poorer day-shift sleep quality for offshore personnel as compared with those onshore, but the groups did not differ in the measures relating to leave periods.

It was also found that the effects of environment (onshore versus offshore) on sleep patterns were more marked than those of the two different onshore shift systems; the results relating to sleep duration are shown in Figure 6.4.1. Age was negatively related to both duration and quality of sleep, but over and above age, number of years of shiftwork experience was negatively related to sleep duration. Thus, the analysis revealed a cumulative effect of shiftwork years which was not accounted for by age. Neuroticism was also negatively related to sleep duration and, more strongly, to sleep quality. In the published paper describing this study (Parkes, 1992a), the findings outlined above are discussed in detail, with reference to the literature on shiftwork and sleep in general, and the characteristics of the offshore environment in particular.

**Figure 6.4.1**
Sleep duration in relation to onshore/offshore environment and shift patterns
7. WORK PERCEPTIONS

The main aims of the analyses reported in this section were: first, to determine whether offshore and onshore groups differed in perceptions of work tasks and the work environment more general, and/or in work satisfaction; and, second, to determine whether there were significant differences on these measures between the individual installations involved in the study.

7.1 MEASURES

The measures used in the present study assessed characteristics of work tasks, and the work environment more generally, which have been found to be important in relation to well-being and satisfaction at work. Measures of work-related social support were also included. The measures used, and the psychometric evaluations carried out, are detailed in Section 2.3.3. For convenient reference, the work perception dimensions described in this section are summarized in Table 7.1.1.

Table 7.1.1
Dimensions of work perceptions

<table>
<thead>
<tr>
<th>Task characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workload</td>
</tr>
<tr>
<td>Work demand, time pressures, and conflicts between tasks</td>
</tr>
<tr>
<td>Discretion</td>
</tr>
<tr>
<td>Autonomy; involvement in decision-making; control over work tasks</td>
</tr>
<tr>
<td>Complexity</td>
</tr>
<tr>
<td>Complexity, variety, and need for concentration and flexibility in meeting task requirements</td>
</tr>
<tr>
<td>Monotony</td>
</tr>
<tr>
<td>Routine tasks; little change from day to day; fixed procedures</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Work-related social support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support from supervisor</td>
</tr>
<tr>
<td>Extent to which supervisor is generally helpful, concerned about the welfare of employees, and praises good work</td>
</tr>
<tr>
<td>Support from work group</td>
</tr>
<tr>
<td>Extent to which colleagues are supportive and can be relied on when things are difficult</td>
</tr>
<tr>
<td>Support from spouse/family</td>
</tr>
<tr>
<td>Extent to which spouse/family is reliable and willing to listen to work-related problems</td>
</tr>
</tbody>
</table>

In addition to the measure of general work satisfaction (which covered the degree to which individual skills and abilities were utilized, the variety and interest in the work, and future prospects), several additional aspects of satisfaction were analysed: satisfaction with the organization as a whole; satisfaction with status; satisfaction with pay levels; and satisfaction with working hours and shift patterns (see Section 2.3.3).
7.2 WORK PERCEPTIONS IN RELATION TO LOCATION, JOB LEVEL, AND AGE

The initial analyses examined the nature and extent of differences in work perceptions and satisfaction levels in the onshore and offshore groups; in these analyses, the effects of age, and of job level (supervisors versus operators), were also examined.

7.2.1 Comparison of onshore and offshore environments

A significant overall difference between onshore and offshore locations was found for one work environment measure, workload; the offshore group perceived workload to be significantly higher than the onshore group. There was also a tendency (p<.10) for the offshore group to perceive their work as more complex. Two aspects of work satisfaction different significantly across the groups. First, onshore personnel and higher scores than those offshore on organizational aspects of satisfaction; this overall difference was very largely accounted for by the item relating to satisfaction with physical conditions of work. Similarly, the onshore group reported greater satisfaction with work hours and shift schedules than the offshore group. Significant findings are summarized in Table 7.2.1.

Table 7.2.1

<table>
<thead>
<tr>
<th>Variable</th>
<th>P</th>
<th>Mean scores</th>
<th>Possible range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workload</td>
<td>.000</td>
<td>1.88</td>
<td>1 - 4</td>
</tr>
<tr>
<td>Organizational satisfaction</td>
<td>.003</td>
<td>9.21</td>
<td>3 - 12</td>
</tr>
<tr>
<td>Satisfaction with work hours and shift patterns</td>
<td>.001</td>
<td>3.43</td>
<td>1 - 4</td>
</tr>
</tbody>
</table>

Higher scores represent higher levels of the factor concerned

1 This column shows the significance of the difference between onshore and offshore groups

7.2.2 Work perceptions of supervisors and operators

Supervisors differed from operators in both work perceptions and satisfaction ratings. Thus, supervisors reported significantly higher levels of workload than operators, together with greater complexity in their work and higher levels of autonomy and discretion. Along with these differences in work perceptions, supervisors also reported higher levels of each of the three measures of work satisfaction. The results are summarized in Table 7.2.2.
Table 7.2.2
Work perceptions and satisfaction: Comparison of supervisors and operators

<table>
<thead>
<tr>
<th>Variable</th>
<th>P 1</th>
<th>Mean scores 2</th>
<th>Possible range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Onshore</td>
<td>Offshore</td>
</tr>
<tr>
<td>Work demand</td>
<td>.003</td>
<td>2.01</td>
<td>2.38</td>
</tr>
<tr>
<td>Discretion/autonomy</td>
<td>.000</td>
<td>2.40</td>
<td>2.95</td>
</tr>
<tr>
<td>Work complexity</td>
<td>.024</td>
<td>21.85</td>
<td>23.15</td>
</tr>
<tr>
<td>General work satisfaction</td>
<td>.038</td>
<td>17.41</td>
<td>19.52</td>
</tr>
<tr>
<td>Satisfaction with status</td>
<td>.033</td>
<td>9.97</td>
<td>10.80</td>
</tr>
<tr>
<td>Satisfaction with pay</td>
<td>.000</td>
<td>3.05</td>
<td>3.55</td>
</tr>
</tbody>
</table>

1 This column shows the significance of the difference between onshore and offshore groups

2 The mean scores are based on data from 148 operators and 23 supervisors

In comparing the mean values for supervisors and operators, two points should be noted. First, the number of supervisors involved was relatively small and, at some sites, supervisors were not included in the sample. This situation was due to different arrangements at different sites, rather than any particular biases. However, to check whether the absence of data from supervisors at some sites influenced the results described above, the analyses were repeated including only those sites at which data for both operators and supervisors were collected. No marked discrepancies were found between the two sets of analyses, and therefore data for the entire sample are reported. Second, the analyses presented here (and in the following sections) only establish the relative positions of the groups in relation to the variables of interest. Thus, for instance, higher workload is reported offshore than onshore but this does not imply that it is very high in one location and/or very low in another.

7.2.3 Age effects

There were no overall effects of age on work perceptions, after differences associated with location and job level had been taken into account. However, age was a significant predictor (p < .001) of satisfaction with working hours and shifts, older workers reporting greater satisfaction.

7.2.4 Interactions

There were no significant interactions between location and job level in the analyses described above; thus, the effects of location are the same at each job level, and the effects of job level apply to both onshore and offshore locations.
7.3 MULTIVARIATE ANALYSES OF WORK PERCEPTIONS AND SATISFACTION

The analyses of single variables outlined above does, not take into account the ways in which particular combinations of variables, as opposed to single measures, may characterize different work environments. Furthermore, the findings are complicated by the relatively large number of measures analysed, some of which are significantly inter-related. Use of a multivariate statistical technique, discriminant analysis (Klecka, 1980), allowed further examination of the differences in perceptions and satisfaction across different work settings. This method enables sets of variables associated with group membership (in this case, those working at different locations) to be identified.

In the present work, discriminant analysis was used to identify the combinations of variables which were associated with (i) onshore versus offshore locations, and (ii) different platforms or installations within the onshore and offshore groups. The analyses were based on data from operators (N = 149); data from supervisors were excluded to avoid possible biases associated with overall differences between operators and supervisors at sites where both groups were involved.

7.3.1 Discriminant analysis: onshore and offshore

When discriminant analysis was applied to work perception and satisfaction data obtained from the onshore and offshore groups, a highly significant discriminant function (Rao’s V = 101.0, p < .0001; canonical correlation = 0.64) was obtained, indicating that a linear combination of these variables distinguished the onshore and offshore environments. The main defining factors which characterized the two locations, their relative importance as reflected in the correlations between variables and discriminant function scores, and the statistical tests of the discriminant function, are summarized in Table 7.3.1.

Overall, the majority of the salient factors appeared to favour the onshore locations; thus, as compared with those offshore, onshore operators report higher levels of organizational satisfaction (including management, and physical conditions of work), and of satisfaction with pay. However, the strongest discriminating factor was satisfaction with shift schedules and work hours, onshore personnel being more satisfied with their work patterns than those offshore. In addition, onshore operators perceived greater work-related support from supervisors and from spouse/family. Offshore operators perceived their work as higher in complexity and variety, and in workload. Factors which did not distinguish the two groups included discretion/autonomy and support within the work group.
### Table 7.3.1
**Discriminant analysis: onshore and offshore locations**

<table>
<thead>
<tr>
<th>Factor loading</th>
<th>Defining characteristic</th>
<th>Higher scores associated with:</th>
</tr>
</thead>
<tbody>
<tr>
<td>.76</td>
<td>Satisfaction with schedules</td>
<td>onshore</td>
</tr>
<tr>
<td>-.48</td>
<td>Workload</td>
<td>offshore</td>
</tr>
<tr>
<td>.34</td>
<td>Organizational satisfaction</td>
<td>onshore</td>
</tr>
<tr>
<td>0.23</td>
<td>Support from supervisor</td>
<td>onshore</td>
</tr>
<tr>
<td>.23</td>
<td>Satisfaction with pay</td>
<td>onshore</td>
</tr>
<tr>
<td>-.20</td>
<td>Work complexity and variety</td>
<td>offshore</td>
</tr>
<tr>
<td>.19</td>
<td>Support from spouse/family</td>
<td>onshore</td>
</tr>
<tr>
<td>.18</td>
<td>General satisfaction</td>
<td>onshore</td>
</tr>
</tbody>
</table>

1. *The factor loadings (correlations between scores on the variables shown and the discriminant function scores) indicate the relative importance of each characteristic in distinguishing between the onshore and offshore locations.*

### 7.3.2 Offshore installations

The same statistical approach was used to identify factors which jointly distinguished the three installations (A1, A2, and A3) within the offshore sample. In this case, separation of the groups required two discriminant functions (the number of linear functions required to separate n groups is n-1). Both the discriminant functions obtained were significant. For the first function, chi-square = 43.44, df = 12, p<.0001, canonical correlation = 0.61; for the second function, chi-square = 11.64, df = 5, p<.04, canonical correlation = .40. Both functions could therefore be interpreted; in combination, they served to separate each group from the two others.

The results can be most readily interpreted in the form of a two dimensional 'territorial plot' (see Figure 7.3.1) in which the first discriminant function forms the horizontal axis and the second one forms the vertical axis. The relative positions of each of the installations can be located within this plot; the mean value for each installation is shown by an asterisk. The characteristics associated with each installation is identified from the discriminant analysis, and the territorial plot shown in Figure 7.3.1 has been annotated to show the factors of particular relevance in each of the three domains.
The A2 group was most clearly differentiated from the A3 group by the first function, while the second (and less highly significant function) served to distinguish the A1 group from the A2 and the A3 groups. Each group thus occupied a particular domain of the plot; in Figure 7.3.1 the areas have been annotated to indicate the defining characteristics of each domain and hence of the group concerned. The results are summarized in the following paragraphs.

- **Group A1.** In group A1, perceived workload tended to be lower than in other groups; tasks were seen as more monotonous; and status and support from spouse/family were perceived to be low.

- **Group A2.** This was the most clearly demarcated group. Most of the defining characteristics were favourable (including higher perceived status, higher discretion/autonomy, and more cohesion and support within the workgroup), although this group also reported low satisfaction with shift schedules, and relatively high workload.

- **Group A3.** This group was most strongly characterized by low levels of satisfaction with physical conditions of work, and the organization as a whole. In addition, social support from supervisors and within the work group was rated relatively low, while workload was perceived to be high.
7.3.3 Onshore installations

The same method of analysis was used to identify the work characteristics associated with each of the five onshore installations. In this case, only two of the four possible discriminant functions were statistically significant. Thus, the data did not allow clear separation of all five groups. Nonetheless, as shown in the territorial plot, three groups were identified by the predictor variables, while the remaining two occupied intermediate positions (see Figure 7.3.2).

Figure 7.3.2
Territorial plot showing the relative positions of the onshore installations

The first discriminant function (plotted along the horizontal axis in Figure 7.3.2) was highly significant (chi-square = 87.66, df = 40, p<.0001; canonical correlation = 0.70); the second function (plotted along the vertical axis) was also significant (chi-square = 42.56, df = 27, p<.03; canonical correlations = 0.56). The domains representing the three most clearly demarcated groups (B1, B2 and B4) are annotated with the factors which characterize them, but groups B4 and B5 are not well separated from the groups bounding them. Thus, groups B3, B4 and B5 showed a number of similarities; in addition, B5 shared some characteristics with B1, while B3 overlapped to some extent with B2. The main characteristics of the three most clearly defined groups are summarized below.

- **Group B1.** Monotonous work, low cohesion and support within the workgroup, low organizational satisfaction, and low satisfaction with pay, were the main characteristics associated with this group.
• **Group B2.** Low workload, and dissatisfaction with hours and shift schedules were characteristic of this group. In addition, the group shared perceptions of monotonous work with the B1 group, and perception of their work as low in status and importance with the B3 group.

• **Group B4.** This group reported relatively high levels of general work satisfaction, of organizational satisfaction, and of satisfaction with pay. It was also characterized by high social support, both within the work group and from the supervisors, and by greater complexity and variety of work than groups B2 and B3.

### 7.4 LOCATION, WORK PERCEPTIONS, AND ANXIETY

The analyses reported in this section examine the extent to which work perceptions are implicated in relations between the objective work setting (onshore versus offshore) and anxiety levels. In addition, the extent to which personality traits (particularly, neuroticism and the 'speed and impatience' component of Type A behaviour) act as underlying factors in individual vulnerability to anxiety is further examined. In effect, these analyses bring together the separate analyses of the effects of location on anxiety (Section 5), and the effects of location on work perceptions (Section 7).

#### 7.4.1 Data analysis

The pathways in the model tested were specified on the basis that location (onshore/offshore), job level, age, and personality (neuroticism and A Type) played causal roles in the stress process, and that work perceptions were the intermediate factors through which offshore work gave rise to higher anxiety than onshore work. Using standard regression methods, two main pathways between location and anxiety were identified (see Figure 7.4.1).

• **Workload.** It was found that onshore/offshore location influenced perceived workload, which in turn predicted anxiety. When workload was included in the predictive model, location no longer had a significant direct effect on anxiety; this finding indicated that workload was an intermediate factor in the relation between location and anxiety. In addition, neuroticism had both a direct effect on anxiety, and an indirect one which operated through its impact on perceived workload. Finally, job level played in part in influencing perceived workload, and hence anxiety.
Figure 7.4.1
Path diagram showing factors implicated in relations between onshore/offshore location and anxiety
• **Dissatisfaction with shift schedules.** Onshore/offshore location predicted the extent of dissatisfaction with shift schedules, and this in turn was related to anxiety. However, the relationship was not a direct one; rather, it incorporated the interactive effect of Type A behaviour reported in Section 6.2.1. Individuals who reported high anxiety were those who were both dissatisfied with shift schedules and high in S-I Type A scores; the form of this interaction was thus similar to that shown in Figure 6.2.1.

The implication of these results is that perceived workload and satisfaction with shift schedules, together with the direct influence of neuroticism, and the indirect influence of the S-I component of Type A, account empirically for the relation between location and anxiety. However, the findings should be interpreted with caution; they cannot be regarded as a complete explanation of the anxiety levels observed offshore. This is particularly true of the role played by dissatisfaction with shift schedules. The analyses reported in Section 6.4 showed that sleep quality and duration were closely associated with schedule dissatisfaction; it was clear that sleep patterns were implicated in the model shown in Figure 7.4.1 in ways that could not be fully examined in the present data. If is therefore more appropriate to draw only the general conclusion that sleep patterns, dissatisfaction with shift schedules, and personality (particularly S-I Type A scores) are all implicated in the causal sequence linking offshore work with anxiety.

However, other work environment factors (including variables not measured in the present study) would also be relevant in explaining mental health outcomes in the offshore environment. It should be emphasized that, although possible causal pathways can be tested in cross-sectional data, such data do not allow clear causal inferences to be made. All that can be established at present is that the data are consistent with the model shown in Figure 7.4.1. To draw more definite causal inferences, longitudinal studies would be required.

### 7.5 WORK PERCEPTIONS AND WORK SATISFACTION

As described in Section 6, the measures of general work satisfaction and anxiety were predicted by different combinations of personality, job level, and onshore/offshore location. However, literature findings suggest that work satisfaction measures are also likely to be related to perceptions of work characteristics, particularly social support from supervisors and workgroup members.

In the regression analyses carried out to examine relations between satisfaction and work perceptions, four control variables (onshore/offshore location, age, job level and neuroticism) were included in the analyses prior to the inclusion of measures of supervisor support, support within the workgroup, and work demand. Thus, the analyses examined the extent to which perceived support and workload predicted satisfaction after effects of the four initial variables had been taken into account. Inclusion of neuroticism in the model was particularly important in this context, as both work perceptions and satisfaction measures are vulnerable to response biases associated with negative affectivity (a general tendency to view self and environment in a negative light), which is assessed by neuroticism. As described below, different patterns of results were obtained for each of the three satisfaction measures, particularly in relation to the nature and direction of the workload relationship.
7.5.1 General work satisfaction

Supervisor support was the major factor predicting general satisfaction (p<.0001); in contrast, support from within the workgroup did not contribute to general satisfaction. Perceived workload was also a significant predictor, but this relationship was curvilinear (represented by a quadratic term) rather than linear. Low levels of perceived workload were associated with low satisfaction; however, a plateau in the satisfaction curve was reached a little above the average workload level and for levels higher than this satisfaction began to decrease.

7.5.2 Organizational satisfaction

Satisfaction with the organization as a whole, including physical conditions of work, was highly significantly related to both support from supervisors (p<.0001) and support within the workgroup (p<.001). In each case, greater perceived support was associated with greater satisfaction. In addition, there was a highly significant relationship between perceived workload and this satisfaction measure; in this case, high demand predicted low levels of satisfaction with organizational factors.

7.5.3 Satisfaction with status

Supervisor support was the most highly significant predictor of the extent to which individuals perceived their jobs as important (p<.0001); support within the work group did not contribute to this aspect of satisfaction. In addition, perceived workload predicted satisfaction with status; in this case, high workload was associated with high satisfaction (p<.002).
8. DESCRIPTIVE ANALYSIS OF WORK CONCERNS

This section was contributed by Ros Savournin, Research Assistant, Department of Experimental Psychology, University of Oxford.

In response to the open-ended question at the end of the final section of the questionnaire - "In your view, what are the most difficult and demanding aspects of the work of control-room operators?" - participants noted a variety of concerns. Their comments can be organized under four general headings: the work environment, personnel, shift patterns, and the nature of the job itself. More detailed coding resulted in eight categories which were used for data analysis. These categories are described below to explain how responses were classified, and as a general review of the issues that were raised.

8.1 CATEGORIES OF PROBLEMS REPORTED

8.1.1 Work environment

This category included all complaints concerned with physical aspects of the control-room work environment, and their effects on operators. Comments referred to confinement and claustrophobia due to long hours in the same surroundings without a break, lack of physical exercise and, less frequently, the effect of continuous VDU work, and fluorescent lighting.

8.1.2 Personnel

Concerns about personnel focused primarily on relationships with supervisors and management staff, and on relationships within the work group.

- **Supervisors and management.** The attitudes of supervisors and managers, as perceived by operators, were the most frequent concerns in this category; problems included unduly high expectations on the part of supervisors and managers, insufficient appreciation of a job well done, and general insensitivity to the needs of the workforce. Under-utilization of skills and abilities, and problems of liaison (eg between senior personnel and operations staff) were also mentioned.

- **Colleagues.** Reported relationships with colleagues varied widely, as would be expected; some operators reported a cooperative and supportive work group, while others clearly did not feel they had encountered one. The social aspect of the work environment is seen as much more important offshore than onshore; in one notable comment reflecting this view, an operator wrote of "The survival factor - a necessity to be tolerant and social to a degree never imaginable to our onshore contemporaries". Another recurrent issue was the tension some respondents felt to exist between company employees and agency workers.

8.1.3 Shifts

This category included all problems arising directly from shiftwork. The most frequent complaints were of tiredness, sleep problems, difficulties with the
changeover between night shifts and day shifts, and the general effect that working shifts has on concentration, performance and mood.

8.1.4 The nature of the job itself

The nature of control-room work gave rise to a number of specific concerns among operators:

- **Interruptions.** The control-room often serves as a centre of communications in addition to its primary role in the monitoring and regulation of production processes. Thus, taking telephone calls, dealing with unrelated enquiries and paperwork, and making tannoy announcements, all tend to interrupt the operators' primary tasks, and disrupt ongoing work. One operator characterized the problem as one of "being able to concentrate and think when alarms sound, telephones ring and printers burst into life all at the same time and someone is asking you a question". Another, more succinctly, noted the problem as "insufficient time away from trivia".

- **Pressure.** Comments in this category referred to pressures arising from the responsibility of the job. More specifically, operators noted the need to respond immediately, usually in isolation (i.e. without back-up from supervisors or management), and in circumstances in which their decisions could have far-reaching consequences. In this context, one operator referred to the pressure of "Being a one-man operation". Comments also tended to emphasize the constant fear of an emergency situation, which persisted even when things were quite. In the words of the offshore operator: "You are responsible for the safety of that equipment and ultimately the safety of all on board". In addition to this responsibility, there is the need to work within certain constraints, e.g. production targets. The difficulties experienced by operators in making the transition from a long period of inactivity (causing boredom and concentration loss) to a situation requiring fast and accurate responses were also noted, e.g. "Plant conditions can stay steady for hours, but can change in seconds".

- **Concentration.** This category brought together problems concerned with staying alert, and maintaining continued concentration and attention during long periods of little or no activity in the control-room. Reports of boredom, drowsiness, and lethargy associated with the tedious nature of the control-room work were frequent. These problems tended to overlap with those described under the heading of 'shifts'; the distinction made depended on whether tiredness and concentration lapses were perceived to be due to the tedious nature of the job itself (included here), or to shift patterns and associated sleep loss (included in Section 8.1.3).

- **Knowledge.** The final category covered concerns about the level of knowledge required for control-room work, including system operations, interpretation of instruments, and procedures to be followed. Operators commented on the difficulty of maintaining the necessary information, and keeping it up to date.
### 8.2 FREQUENCIES OF PROBLEMS REPORTED

Table 8.2.1 shows the percentage of operators whose primary concern, as reflected in their open-ended comments, fell into each category. Only the primary concern noted by each operator was used in this analysis, although many respondents commented on more than one issue. Thus, although the data provide a general picture of the problems reported, the analysis is limited in that it does not take into account further interesting comments which were secondary to the major concern classified.

#### Table 8.2.1

**Difficult and demanding aspects of control-room work: primary concerns**

<table>
<thead>
<tr>
<th>Concern</th>
<th>Full sample</th>
<th>Onshore</th>
<th>Offshore</th>
<th>Rank(^1)</th>
<th>(%)</th>
<th>Rank(^1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure and responsibility</td>
<td>28.1</td>
<td>22.4</td>
<td>33.8</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Concentration</td>
<td>28.1</td>
<td>38.8</td>
<td>17.6</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Interruption</td>
<td>13.3</td>
<td>10.4</td>
<td>16.2</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Shifts</td>
<td>9.6</td>
<td>9.0</td>
<td>10.3</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Work environment</td>
<td>7.4</td>
<td>4.5</td>
<td>5.9</td>
<td>6</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Knowledge</td>
<td>6.7</td>
<td>4.5</td>
<td>8.8</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Colleagues</td>
<td>3.7</td>
<td>3.0</td>
<td>7.5</td>
<td>7</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Supervisors</td>
<td>3.0</td>
<td>3.0</td>
<td>2.9</td>
<td>8</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>135</td>
<td>67</td>
<td>68</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The number of operators whose primary concern falls into each category is shown as a percentage of the total respondents to the question.*

\(^1\) *The rank orders of concerns in each group are shown in these columns.*

In the discussion that follows, the frequencies with which different concerns were noted is examined in relation to the three factors: location (onshore and offshore); job level (supervisors and operators); and individual installations.
8.2.1 Onshore and offshore environments

There was no overall significant difference between the onshore and offshore environments in the frequency with which different problems were noted (chi-square = 9.40, df = 7, ns). The rank orders of the eight categories of primary concerns outlined above are shown in Table 8.2.1, for onshore and offshore workers separately, together with percentages in each category. When each category was considered individually, the only significant differences between the two groups was in complaints concerning concentration lapses, which were more prevalent in the onshore group. However, this effect was entirely accounted for by one onshore installation (B3) where concentration was the primary concern of 62% of respondents; in other onshore locations concentration problems were reported no more frequently than offshore.

8.2.2 Job level: supervisors and operators

The types of concerns reported were not significantly related to job level. No overall significant difference in frequencies was found between supervisors and operators (chi-square = 9.11, df = 7, ns). More detailed analysis was limited by the small size of the supervisor group, but it was clear that both groups were concerned about the same issues.

8.2.3 Installations

In contrast to the non-significant findings relating to location and job level, operators' primary concerns varied widely between different installations. An overall measure of the extent of this difference was highly significant (chi-square = 85.06, df = 49, p=.001). The individual categories which largely accounted for this result were 'interruptions' (chi-square = 16.34, df = 7, p = .022) and 'problems of concentration' (chi-squared = 35.41, df = 7, p <.0001). However, in both these cases, the results were attributable to one installation which differed from all the others. As mentioned above, B3 had a greater proportion of operators reporting concentration difficulties than any other site, while A2 operators were more likely to report interruptions than operators at any other site. Conversely, B3 operators did not report interruptions problems, and A2 operators rarely reported concentration problems; this difference reflects the nature of the control-room environment in the two settings.

8.3 OVERVIEW

The material in this section complements the more quantitative analyses presented elsewhere in this report by reflecting the concerns the operators' presented themselves chose to comment on when asked about control-room work in an open-ended question. The wording of the time was such that it did not elicit a general comparison of the onshore and offshore environments, but it did reveal the major areas of concern among operators which showed an overall similar profile onshore and offshore. It also demonstrates the potential value of open-ended questions in throwing further light on quantitative results.
9. CONCLUSIONS

The present study was unusual, and possible unique, in that it allowed direct comparisons of measures of well-being and work perceptions between groups of offshore and onshore personnel carrying out similar work. The results showed that, in general, offshore workers tended to perceive their environment less favourably than those employed onshore, and that mental health and some aspects of work satisfaction were also lower among the offshore employees. However, differences between the two groups in personality and in reports of minor health complaints were not significant, with the exception of sleep problems which were more prevalent offshore. Separate locations within the onshore and offshore groups showed significant differences but on the whole these were less marked than the overall onshore/offshore differences.

Before addressing issues arising from the more detailed findings, it is appropriate to return initially to the first issue raised in the Introduction, that is, the extent to which onshore and offshore employees differ in scores on mental health measures.

9.1 MENTAL HEALTH, ONSHORE AND OFFSHORE

The overall finding that scores on the anxiety measure were significantly higher for the offshore personnel as compared with those onshore is of interest in relation to the two previous studies of mental health among offshore workers. The present results are not in accordance with those of Gann et al. (1990) who found no significant differences in either anxiety or depression between onshore and offshore employees undergoing medical examinations.

Several reasons for this discrepancy can be suggested. First, in the present study, data were collected at the work location (whether onshore or offshore), and in the context of a wider study carried out by independent researchers. In contrast, Gann et al collected their data in a company medical department; thus, it is possible that differences between the two groups were obscured by the fact that all personnel were onshore at the time of data collection. Furthermore, Gann et al. used job levels rather than actual work as the basis of detailed comparisons of mental health in the onshore and offshore populations, whereas in the present study all participants were engaged in similar work.

The present findings, as they relate to anxiety among offshore employees, are in general agreement with those of Sutherland and Cooper (1986). However, these authors also suggested that obsessional symptoms were high among offshore personnel, whereas no other types of psychological symptoms were found to differ significantly between onshore and offshore groups in the present work. In comparing findings from the two studies, it should be noted that the limitations of Sutherland and Cooper's work are to a large extent eliminated in the study described here. Thus, the present study had a response rate in excess of 90%; the data were collected on site rather than by mailed questionnaire; an onshore group carrying out the same type of work was compared with the offshore group; and the overall comparison of anxiety levels was controlled for the significant age difference between the onshore and offshore groups.

Thus, the present work largely overcomes the methodological problems which left Sutherland and Cooper's conclusions open to some doubt. However, as personnel in
only one occupational category were included in the present study, is not possible to
know how far the findings would apply to offshore employment more generally.
Furthermore, comparison of onshore and offshore anxiety levels does not in itself
indicate whether the onshore value is lower than would be expected relative to the
general population, or whether the offshore group is higher than would be expected.
No conclusive answer is possible; however, examination of the present data in
relation to published data for personality measures known to be predictive of mental
health, and published data for symptoms scores, suggested that the latter was the
case, ie that the offshore group were reporting higher levels of symptoms than would
be expected from their scores on personality measures.

9.2 THE ROLE OF TYPE A PERSONALITY

For comparison with other published studies only the overall difference in anxiety
between the onshore and offshore groups was relevant. However, the real interest in
the present work lay not so much in the overall association between offshore work
and anxiety, but in findings suggesting that Type A behaviour combined with
features of the offshore environment, and with age, to give rise to elevated anxiety.

Thus, high anxiety was characteristic of offshore workers who also had high scores
on the 'Speed and Impatience' (S-I) component of the Type A scale. Among onshore
employees, high S-I scores were not associated with high anxiety; also, offshore
workers with low S-I scores did not differ significantly in anxiety from onshore
workers. Only the combination of high S-I scores and the offshore work
environment was predictive of high anxiety. Furthermore, the relationship between
S-I scores and anxiety was significantly influenced by age; among older offshore
personnel, S-I scores were more strongly related to anxiety than among those who
were younger. Thus, at the younger age levels, the implications of high S-I traits
were less serious than among those who were older. It should also be noted that
these findings applied specifically to the 'S-I' component of the Type A measure used,
and not to the 'Competitive Drive' (C-D) component which was implicated in work
satisfaction but not anxiety.

The findings relating high S-I traits to anxiety among offshore personnel are more
revealing than overall differences in mental health between onshore and offshore
employees, as they suggest that particular personality traits may make employees
vulnerable to impaired well-being in the offshore environment. Results which take
the form of an interaction between personality and environment are also much less
open to alternative explanations than overall differences between onshore and
offshore groups (which could, for instance, be ascribed to pre-existing, unmeasured
differences between the two groups). To interpret the interactive relationships
observed in the present study, it is necessary to explain why anxiety is significantly
related to S-I scores in the offshore setting but not onshore, and why this relationship
is stronger among older offshore personnel than among those who are younger, which
inherently directs explanations towards the nature of the settings concerned.

Furthermore, the interactive effects observed were very robust; they remained
statistically significant after control for age, job level, and neuroticism. In addition,
the three separate locations within the offshore group all showed a similar positive
relationship between S-I and anxiety, while the absence of such a relationship was
consistent across all the five onshore groups. In the following sections, the Type A
behaviour pattern is considered in relation to literature findings and the nature of the
offshore environment, and the practical implications of the present work are examined.

9.2.1 Research into Type A behaviour

The research literature suggests that, relative to Type B individuals, Type A's are impatient with delay; perform less well on tasks requiring delayed responses; prefer to work alone when under stress; and react with impatience when completion of a task is interrupted by the actions of another person. Kirmeyer (1988) reviewed this literature, and reported that Type A behaviour was also implicated in police despatchers' perceptions of overload when exposed to interruptions and competing demands at work. These findings are relevant to the work of control-room operators, and are consistent with the view that the adverse effects of Type A behaviour may be accentuated by the demands and constraints of offshore work.

High scores on the various components of Type A behaviour have been found to predict health problems, particularly cardiovascular disease (e.g. Haynes et al. 1980). High Type A's also tend to show greater anxiety, muscle tension, and job strain (Burke & Weir, 1980; Kittel et al. 1983). Specifically in relation to offshore workers, Cooper and Sutherland (1987) found that Type A behaviour was the strongest predictor of each of six symptom measures they examined; however, this analysis is difficult to interpret as there is no control for neuroticism or 'negative affectivity' (which could account for a large part of the relationships observed), and the significance of the separate predictor variables is not reported. In a more recent paper, Sutherland (1992) further emphasizes the implications of Type A behaviour in the offshore environment, noting the potential vulnerability of high Type A individuals to both accidents and impaired well-being in the offshore environment.

There are several reports in the literature of person-environment interaction effects such as that observed in the present study. For instance, Chesney and Rosenan (1980) found that individuals with high Type A scores responded with high anxiety to environments over which they had little control but this was not true of Type B individuals. Similarly, Rhodewalt et al. (1984) reported that work stress measures interacted with Type A to predict psychological impairment and cardiovascular-related health problems (higher levels of symptomatology being shown by Type A's exposed to higher levels of work stress), while Newton and Keenan (1990) provided longitudinal evidence of similar interactive effects of Type A and the work environment. More generally, Ivancevich and Matteson (1984) discuss some of the difficulties likely to be encountered in research which seeks to examine the role of Type A in work settings.

9.2.2 S-I Type A scores, anxiety, and offshore work

In attempting to identify the features of offshore work which may be sources of particular frustration and anxiety among individuals with high S-I scores, it is necessary to consider aspects of the work situation which characterize the offshore environment but do not apply, or apply to a lesser extent, onshore. Several points merit attention.

- **Environmental constraints.** Both onshore and offshore, oil and gas production necessitates close adherence to regulations and fixed procedures to ensure the safety of employees and plant. However, the confined nature of
the offshore environment, its isolation, and its exposure to the elements, is such that there are more potential hazards to be guarded against, and the consequences of failures and oversights are likely to be more serious; thus, offshore work is subject to more extensive regulation and constraint than that onshore. In addition, offshore workers cannot return home at the end of a shift but remain offshore for continuous periods of two weeks. Thus, both in the extent to which constraints are necessary, and in the duration of continuous exposure, offshore personnel work under more demanding conditions than those onshore.

The nature of the constraints encountered offshore (associated, for instance, with confined work and accommodation areas; the work permit system, and other essential safety procedures; restrictions on smoking, and the use of electrical equipment; noise, and its effects on communication; lack of privacy; and even seemingly minor problems such as having to queue to make personal telephone calls to onshore locations) are likely to be particularly frustrating for high S-I individuals, whose natural tendency is to act speedily and who rapidly become impatient if delayed or restricted in meeting their objectives. The combination of high S-I tendencies and the offshore environment is also a potential source of accidents: Sutherland and Cooper (1986) and Sutherland (1992) note that those who reported that they had on some occasion been involved in an accident offshore, were significantly higher in Type A scores than those who reported no accident involvement.

• **Shift schedules and work/leave patterns.** Shift schedules, and work/leave cycles, are different for onshore and offshore locations. Offshore, all participants in the present study worked the same shift pattern (12 hour shifts, 7 Night shifts followed by 7 day shifts, in a two-week period of offshore work). Onshore, several different shift patterns were in operation. Overall, onshore employees reported significantly higher levels of satisfaction with shift patterns than offshore employees; this factor discriminated strongly between the two groups. Furthermore, greatest dissatisfaction with shift schedules was reported by the offshore personnel located on the most remote platform for whom shift patterns and travel times were inter-related problems.

Dissatisfaction with shift patterns was found to act as a mediating factor in the relation between offshore location and high anxiety in high S-I individuals. Thus, offshore work was associated with shift schedule dissatisfaction, which was predictive of anxiety in high S-I (but not low S-I) individuals. Reported sleep quality and high S-I scores were also related to dissatisfaction with shift schedules. It is possible therefore that shift patterns which lead to poor quality of sleep among offshore workers may be indirectly implicated in the anxiety reported by high S-I individuals. For instance, inability to sleep, or disturbed sleep, may give rise to particular anxiety and frustration among individuals prone to impatience and irritation, and this irritation may itself serve to make sleep more difficult. Age is also relevant in this context, as older employees in the present sample reported shorter sleep duration and poorer sleep quality than their younger counterparts; this finding is consistent with the possibility that relations
between S-I traits and anxiety are mediated (or partially mediated) by sleep problems.

Lavie et al. (1989) reported data suggesting that sleep disturbance acts as a marker for a more general inability to adapt to shift work, as indicated by work dissatisfaction, higher incidence of hypertension, greater frequency of accidents, greater use of medication, and higher morbidity. However, the present study indicated that sleep measures were also related to differences in neuroticism; thus, it is not clear whether sleep disturbance per se is the marker for adaptation problems among shift-workers or whether neuroticism plays an underlying role.

• **Work of control-room operators.** The present results also raise questions as to whether the nature of the work carried out by control operators onshore and offshore differs in ways which may have implications for anxiety among high S-I individuals. In general, control tasks are characterized by fluctuating workload (with periods of boredom interspersed with periods of high activity) rather than continuous high workload; by interruptions and demands (such as phone calls, and communication tasks) unrelated to the primary tasks in hand; and by the need for careful record-keeping and adherence to set procedures. Whilst superficially there are many similarities between the work carried out onshore and offshore, it is possible that a more detailed examination of the work patterns, interruptions, and responsibilities, of onshore and offshore operators would reveal differences with implications for anxiety in high S-I individuals. For instance, evidence that interruptions were perceived as disruptive on at least one of the offshore platforms (A2) was apparent from the analysis of the topics raised in the open-ended section of the questionnaire (see Section 8). Differences in the physical environment of control-rooms onshore and offshore may also be relevant. For instance, onshore control-rooms tend to be more spacious, and may also have windows looking out on the production site, thus not only providing a visually relaxing amenity, but also providing potentially useful information about operating activities.

• **Travel to and from the offshore environment.** Travel to and from offshore work may also be relevant in relation to high S-I characteristics. Whilst helicopter travel is a source of stress for many offshore workers (Hellesoy, 1985), time-consuming procedures (e.g. pre-flight check-in; baggage checks; survival suits; and safety briefing) together with possible helicopter delays, are more likely to promote impatience and anxiety among high S-I individuals.

• **Contrasting features of the onshore environment.** In focusing attention on the environment and work of offshore personnel, it is important not to ignore potentially salient features of the onshore environment. The great majority of onshore personnel who took part in the present study were employed at installations located in rural, uncrowded, and relatively remote coastal areas. Thus, the onshore group were not only free from the constraints experienced by their offshore counterparts, they were also not exposed to the many daily stressors (including road congestion; parking problems; urban noise and air pollution; population density; queues; restricted office space) with which people working in crowded urban environments have to cope daily.
The question thus arises as to whether the lack of association between high S-I scores and anxiety in the onshore group was partly due to the largely rural surroundings in which most of them lived and worked. In these respects, the onshore environment represented a particularly marked contrast with the offshore environment. It is possible that a comparison group working in an urban area would have shown a stronger relationship between S-I scores and anxiety than was observed for the onshore group in the present work, i.e. personnel carrying out demanding work in urban environments might have produced results not unlike those of the offshore group in the present study.

However, although the contrast in lifestyles may have accentuated the present findings, it is unlikely that the environment of the onshore group would entirely explain the results observed, particularly as the offshore group reported higher overall anxiety levels than would have been anticipated from their scores on measures of extraversion and neuroticism. Furthermore, medical requirements for offshore work are such that the offshore personnel are a particularly 'healthy-worker' group in whom above-average mental health would be expected.

### 9.2.3 C-D Type A scores, satisfaction, and offshore work

For two specific aspects of work satisfaction (satisfaction with work hours and shift patterns, and with management and the organization as a whole), offshore workers reported significantly lower levels than those onshore. In contrast, on the broad measure of general work satisfaction, the onshore and offshore groups did not differ. However, the regression analyses showed that, in the offshore group, general satisfaction was positively related to scores on the Competitive Drive (C-D) Type A measure, whereas the relationship was non-significant (but tended to be negative) in the onshore group. Thus, among those high in C-D traits, offshore workers reported higher satisfaction than those onshore, whereas the reverse was true of those who low C-D scores (see Figure 6.2.4). Thus, C-D traits had important positive implications for well-being in the offshore environment, but among onshore workers the tendency was for high C-D traits to have a negative impact on satisfaction.

The further observation that high C-D traits were directly related to an expressed preference for working offshore rather than onshore (see Section 6.3) throws further light on these interactive findings. Thus, in spite of the demands it imposes, offshore employment can offer opportunities and challenges not provided by similar onshore jobs: in particular, pay rates are substantially higher than in comparable onshore jobs; the work of offshore control-room operators tends to be more complex and varied than that onshore; and relatively long periods of leave allow offshore workers time to pursue hobbies and sports, to travel on holiday, or to take casual employment. Individuals scoring high on the measure of C-D traits tend to be ambitious, competitive, and keen to get ahead in their careers; thus, they may make a definite choice in favour of offshore work, and the advantages it offers may account for the relatively high level of satisfaction reported by high C-D individuals working offshore.

Conversely, some offshore employees in the present sample appeared to have been motivated to seek offshore employment only because of redundancy from onshore job, and the lack of alternative employment opportunities in their local area. It can
be suggested that these individuals are more likely to be low in C-D traits; having been forced through circumstances beyond their control to seek offshore work, they tend to experience low satisfaction and retain a preference for working onshore.

9.3 TYPE A AND THE OFFSHORE ENVIRONMENT: PRACTICAL ISSUES

Whilst the present results would require further confirmation before justifying any specific action, it is nonetheless of interest to examine their potential implications. In principle, the findings suggest that high anxiety offshore could be alleviated either by reducing the S-I component of Type A behaviour among offshore personnel, or by changing the offshore environment to reduce the impact of features to which high S-I individuals respond adversely. In practice, neither approach is without problems.

9.3.1 Environment-based approaches to intervention

In the management and alleviation of work stress, modification of adverse work conditions should normally take priority over interventions intended to change individual behaviour. However, many characteristics of offshore work are inherently linked to the isolated location, the nature of oil and gas extraction processes, and the over-riding need for safe operation of the installation. Thus, critical factors influencing the lifestyle of offshore workers cannot readily be changed. In this case, therefore, scope for an environment-based approach is likely to be limited to psychosocial and organizational factors rather than applicable to more fundamental aspects of offshore work.

Furthermore, in order to recommend change in any particular circumstances, it is necessary to identify the most effective areas of intervention; several ways in which offshore work conditions may combine with S-I behaviours to give rise to anxiety are outlined above, but the present work does not provide clear evidence as to which are most important. While it does appear from the present data that shift schedules and sleep patterns (particularly during day-shift work) may be one factor in the causal process - and here there could be some scope for change - other possibilities for interventions directed towards psychosocial factors merit further research attention.

9.3.2 Person-based approaches to intervention

Two approaches to the reduction of Type A behaviour in individuals and/or the workforce as a whole, can be suggested.

- **Selection of personnel.** It is possible that individuals high in Type A behaviour in general, and in the S-I component in particular, could be identified and screened out in medical examinations or other interviews at the pre-employment stage. Sutherland and Flin (1989) raise the issue of psychometric assessment in selection for offshore work, and the present results suggest that Type A personality would merit consideration in this context.

However, one potential problem with this approach is that the S-I component is related to other aspects of the overall Type A pattern, which have more positive implications in relation to offshore employment; in particular, analysis of the work preference data suggested that high scores on the Type
A component 'Competitive Drive' (C-D) may motivate individuals to seek work offshore. Furthermore, high C-D scores were predictive of high work satisfaction among offshore workers, whereas this was not true of those onshore. Thus, personality characteristics which lead individuals to opt for offshore work, and which tend to be predictive of work satisfaction and achievement generally, are inherently linked with the high S-I scores which appear to play a causal role in promoting anxiety in the offshore environment.

• **Changing Type A behaviour at an individual level.** An alternative approach is to attempt to reduce the problematic aspects of Type A behaviour by education and behavioural intervention programs. Research in this area has been reviewed by Ivancevich and Matteson (1988) and Roskies (1987). In general, such interventions have focused primarily on managing stress and tension which results from Type A behaviour rather than changing the S-I tendencies, or other traits associated with this behaviour pattern. Also, the main focus has been on reducing coronary heart disease, rather than preventing psychological distress.

### 9.4 WORKLOAD, NEUROTICISM, JOB LEVEL, AND ANXIETY

#### 9.4.1 Workload

In attempting to explain the mental health difference between the onshore and offshore groups, the pathway involving workload and neuroticism in the link between the offshore environment and anxiety (see Figure 7.4.1 in Section 7.4) should not be disregarded. The data analyses indicated that perceived workload was significantly higher in the offshore environment than it was onshore and that perceived workload was directly related to anxiety. Thus, in part, differences in anxiety between onshore and offshore environments were mediated by perceptions of workload in the two locations, offshore workers perceiving higher workload than those onshore.

To set these results in context, it should be noted that the workload measure used focused on time pressures and conflict between task demands, and that the overall ratings of both onshore and offshore groups tended to be lower than those observed for a number of other occupations with whom the same scale has been used (Parkes, unpublished data). Indeed, the comments of the onshore group indicated that low workload and periods of boredom were more of a problem than high workload, and this finding was reflected in a curvilinear relationship between perceived workload and general work satisfaction in the sample as a whole. Thus, low perceived workload was associated with low satisfaction; satisfaction increased as perceived workload increased up to a little above the mean workload level and then began to fall again.

Whether onshore or offshore, control-room operations do not normally involve continuous high workload; more usually, the work is characterized by fluctuations in demand, periods of high activity (often of sudden onset) being interspersed with periods in which production runs smoothly and work demand is relatively low. It is likely that the higher overall rating of workload offshore reflects more frequent work fluctuations, and longer periods of demanding work, than are experienced by control-room operators working onshore.
9.4.2 Neuroticism

Neuroticism also played an important role in anxiety, both directly, and through its association with perceived workload; irrespective of whether they worked onshore or offshore, those who scored high on the neuroticism scale reported relatively high levels of anxiety (and minor health problems, and sleep disturbances). They also reported higher levels of workload than their low neurotic counterparts, although there was no reason to suppose that they were actually exposed to higher objective workload; rather it is probable that subjective perceptions of workload were influenced by the general tendency of high neuroticism scorers to 'accentuate the negative'. Similarly, neuroticism was significantly and negatively correlated with the work satisfaction measures.

These findings are consistent with literature suggesting that neuroticism assesses a tendency to view both self and environment in a negative light (Watson & Clark, 1984; Watson & Pennebaker, 1989); they highlight the importance of taking neuroticism into account in research into relations between work conditions and mental health. Neuroticism was in fact the strongest single predictor of reported anxiety over and above the effects of neuroticism. In addition, the association between neuroticism and anxiety was the same onshore and offshore; there was no evidence to suggest that high neuroticism scores were associated with different mental health outcomes in the two locations, as there was for the Type A measure.

9.4.3 Job level

The analysis also showed that supervisors reported higher levels of perceived workload than operators, thus implicating job level in anxiety. Further analyses showed that supervisors tended to have relatively high anxiety levels even if they were low in neuroticism, whereas operators showed the more usual pattern of low anxiety associated with low neuroticism (Parkes, 1992b). The role of the supervisor imposes a heavier burden of responsibility than that of operator, especially when production difficulties arise; the higher perceived workload reported by supervisors as compared with operators is therefore most probably attributable to work that is objectively more demanding. This higher perceived demand may underlie the high anxiety reported by supervisors irrespective of their levels of neuroticism. Supervisors also reported greater complexity in their work and higher levels of autonomy and discretion, but these differences did not appear to be implicated in the pathways leading to anxiety.

9.5 WORK PERCEPTIONS, ONSHORE AND OFFSHORE

It was clear from the multivariate analyses that onshore and offshore locations were associated with different combinations of perceived work environment and work satisfaction variables; this was also true when the same variables were used in separate analyses to discriminate the three offshore platforms, and the five locations in the onshore group. The two characteristics which distinguishes most strongly between the onshore and offshore locations were satisfaction with shift schedules and perceived workload; shift satisfaction was higher onshore, while workload was perceived to be higher offshore. As discussed above, both these variables were implicated in the effects of location on anxiety. The overall profile of variables which jointly distinguished onshore and offshore locations also favoured the onshore locations. One predictable difference between onshore and offshore personnel was
that those working onshore reported more work-related support from their families than the offshore personnel.

However, the results of greater interest in this context related to differences between individual installations rather than the overall onshore/offshore comparison. The three offshore platforms and the five onshore sites differed not only in location but in many other factors including age, history, planned 'life expectancy', the degree of sophistication of the plant and associated monitoring equipment, and whether the production process being controlled was on site or remote. All these factors influence the nature of the tasks carried out by operators and the conditions under which they work. These differences, together with psychosocial aspects of the work environment, are reflected in the profiles of work factors which typified each of the sites involved in the present study. Relevant factors included workload, monotony and complexity of work; perceived status; several aspects of satisfaction; and social support from supervisors and the workgroup.

9.5.1 Offshore locations

Offshore, each of the three platforms was found to have a particular 'profile' of characteristics; in general, locations A1 and A3 were perceived less favourably than A2, but the features identified differed in each case. On platform A1, work tended to be seen as undemanding, monotonous, and low in status. Morale was also low on platform A3, but in this case the main problems were relatively low social support (although shift teams tended to differ in these respects), and lower satisfaction with management and physical conditions of work.

A2 operators perceived their work situation more favourably than the A1 and A3 groups in almost all respects, except for their low satisfaction with shift schedules. A2 operators also reported relatively high workload levels; their open-ended comments revealed a high level of concern about the frequency with which control-room operators had to respond to interruptions and demands unrelated to control tasks.

To some extent, the favourable perceptions reported by the A2 group reflected the better physical environment of a larger and more modern platform, the more sophisticated facilities for control and monitoring tasks, and the more complex and autonomous work carried out. Whilst these factors would not necessarily account for differences in psychosocial variables such as social support, better communications and more spacious work and recreation facilities provide more favourable opportunities for social interaction.
9.5.2 Onshore locations

Onshore, three locations were clearly differentiated by the discriminant analyses, while the remaining two shared some characteristics with other locations. The particular combinations of features associated with different sites differed from those found for the offshore group. Thus, B1 operators reported high workload and high status, but greater dissatisfaction with management and with pay, and less workgroup support. B2 personnel perceived low workload and boring work; they were also least satisfied with shift schedules. B4 reported generally high levels of satisfaction and social support, although the highest level of supervisor support was reported by B5 personnel. In general, neither B5 nor B3 differed greatly from B4, although B3 shared some characteristics with B2. As in the case of the offshore locations, the difference in work perceptions to some extent reflected the different circumstances of the onshore sites concerned, particularly their age, technical sophistication and 'life expectancy'.

9.5.3 Social support

Whilst the combinations of work characteristics discussed above significantly differentiated the groups, and served to identify the particular problems and satisfactions characteristic of different installations, the magnitude of the differences should not be overestimated. For instance, although the measures of work-related support significantly discriminated different locations and groups in the study, in general, overall ratings of support (both from supervisors and within the workgroup) were comparable with, or better than, those reported in Hellesoy's (1985) research. Only the location reporting the lowest levels of supervisor and workgroup support in the present study (A3) compared unfavourably with the Statfjord sample. However, the issue of social support is of particular significance in the context of offshore work for number of reasons:

- As reviewed by House (1981), research findings emphasize the important role of support in mitigating stress and promoting well-being at work.

- Poor relationships at work are a source of concern among process-control operators, both onshore (Vaernes et al., 1988) and offshore (Cooper and Sutherland, 1987).

- In the present study, differences in perceived social support were apparent at three organizational levels (between onshore and offshore groups overall; between different locations within the onshore and offshore groups; and, in some cases, between different shift teams).

- The support available from family members is limited during offshore work periods, and consequently support in the work situation assumes a greater importance.

In that many aspects of the offshore environment are not readily modifiable, attention given to promoting a more supportive environment in setting where support is perceived to be low could serve as an important means of improving work satisfaction and well-being among offshore workers, and of enhancing safety. In particular, Hellesoy (1985) draws attention to research findings which suggest that
'social support provided and received on the platform is the backbone of safety and efficiency' (p.2).
10. FURTHER WORK

Several areas of possible further research can be suggested that would develop and extend the findings of the questionnaire survey described in this report, and would be of potential value as part of a longer-term research plan. These areas are noted below.

- **Other occupational groups.** In the present study, data were collected only from control-room operators and others carrying out similar work; thus, the extent to which the findings would extend to other occupational groups involved in offshore work is not known. It would therefore be of interest to include offshore and onshore employees engaged in different types of work in any further research.

- **Longitudinal research into work and well-being among offshore employees.** In the present survey, data were collected at only one point in time. However, longitudinal research into offshore work adjustment is needed to clarify the processes by which the offshore environment may give rise to impaired well-being and, if necessary, to develop possible intervention strategies. In particular, the findings of the present study suggest that the nature of the interactions between work conditions, Type A behaviour, sleep problems and anxiety among offshore employees would merit further research attention.

  The role of work-related support in mitigating anxiety and promoting work satisfaction is also of interest in this context. The present data could usefully serve as the initial phase of a longitudinal study; following up the present sample (including both onshore and offshore employees) in, say, two years time, would be a useful extension of the work described here. Alternatively, if a suitable opportunity existed, it would be of interest to carry out a longitudinal study of human factors (particularly the psychosocial work environment) on a new platform, and to examine their impact on the well-being of workers moving to the new installation.

- **Perceptions of risk in offshore environment.** The present study did not include data on offshore employees' perceptions of the risks associated with offshore work, or assess their perceived ability to cope with potential hazards and emergencies. It would be expected that risk perception and perceived coping ability would be predicted by a combination of organizational, personal, and environmental factors, including company safety policy and the 'safety culture' more generally, dissemination of safety information, survival training, design features of the offshore installation concerned, and individual differences in experience (e.g. length of time working offshore) and personality (e.g. locus of control).

  These factors may have important implications for anxiety and for safety attitudes among employees in the offshore environment. There appears to be little existing research in this area, and the topic is clearly one which would merit study. Whilst cross-sectional survey methods could make a significant contribution to such a study, longitudinal work would also be of value. For instance, if perceptions of risk could be assessed over a period during which safety modifications were carried out offshore, it would allow examination of
whether the increased objective safety potentially provide by structural and engineering enhancements have a direct impact on offshore workers' subjective perceptions of risk.

- **Offshore work and family life.** The literature suggests that offshore work has a marked impact on marriage and family life. However, this research has largely been carried out from a sociological perspective. A psychological approach would also be valuable; relevant topics include the extent to which the personalities and coping styles of the offshore employee and partner predict successful or unsuccessful adjustment to offshore work; the role of the partner's social network in maintaining well-being during the offshore employee's absence; adaptation to offshore work at different life stages; ageing and its implications in the offshore environment.
PART II
Alertness, sleep, and cognitive performance
1. INTRODUCTION

Shift work plays a major role in many industrial operations, particularly those involving continuous production. Research findings suggest that the adverse effects of shift work include short-term impairment (such as reduced alertness) and performance deficits, and longer-term consequences including poorer health and well-being, sleep problems, lower work satisfaction, and disruption of social and family life. This, shift work has far-reached consequences for employees and their families, and is seen as a source of stress among blue-collar workers (Monk & Tepas, 1985).

The extensive literature on shift work covers a variety of research approaches, including self-report surveys of health and work satisfaction among shift workers; accident studies; field-based research into the physiological, psychological, and behavioural effects of different shift schedules; and laboratory studies intended to investigate more fundamental aspects of night work and irregular sleep patterns. However, this literature relates almost exclusively to the problems of shift work among onshore employees, and among military and naval personnel; offshore oil and gas installations have rarely features in research studies of shift work. Furthermore, as outlined below, several aspects of the offshore environment contribute to the problems of offshore shift workers over and above those of their onshore counterparts.

- Offshore employees typically remain in the constrained and demanding environment of the oil rig or platform for periods of two weeks, rather than leaving the work site at the end of each shift; thus, the problems of cumulative fatigue may be greater.

- The isolation of offshore installations, and the necessity of helicopter travel, precludes the use of shift schedules in which short phases of intensive work are interspersed with more frequent breaks. Thus, the shift patterns used offshore differ from those in operation onshore and tend to be less favourable. In particular, fast-rotating schedules have been recommended for onshore shift workers on the basis of research into sleep and performance (Tilley et al. 1982), and tend to be preferred by employees (Knauth & Kiesswetter, 1987). However these schedules (in which no more than two or three consecutive night shifts are worked) cannot readily be implemented in the offshore environment.

- Shift schedules which impose particularly heavy demands on employees are in operation offshore because efficient scheduling of work and leave periods is facilitated by adopting the same shift pattern in each two-week cycle, and because offshore workers prefer to work day shifts immediately before going on leave. Thus, a typical shift pattern for offshore personnel engaged in continuous production activities is seven night shifts followed immediately by seven day shifts. More generally, 34% of operator personnel in the Statfjord study reported working a pattern of mixed day/night shifts (Hellesoy, 1985).
The round-the-clock activity necessitated by continuous production, together with shared living accommodation, may not be conducive to rest and sleep during off-duty periods. In particular, noise is seen as a major problem offshore; in Hellesoy's (1985) study, 52% of the operator personnel reported dissatisfaction with noise, a much higher proportion than were dissatisfied with any other feature of the physical environment.

The existing literature provides little information about the short-term effects of offshore shift patterns on the alertness and performance of employees, or about the longer term effects of these work schedules on health and well-being. A study by Soviet scientists (Alekperov et al. 1988), which examined work patterns on drilling rigs in the Caspian Sea, appears to be the only research into offshore shift work to be published in the scientific literature. On physiological grounds, this study recommended a 7-day work/rest schedule rather than a two-week schedule, such as that commonly adopted in North Sea operations.

In the absence of research into offshore shift schedules and their effects on employees, it is necessary to draw on more general studies of shift work to review the possible implications of offshore work schedules. Sutherland and Cooper (1989) outline some of this literature in relation to the oil and gas extraction industries, while Monk and Tepas (1985) and Hurrel and Coligan (1985) provide more general reviews of shift work. More specifically relevant to the present work, a number of studies have investigated the extent to which shift duration and work/rest schedules influence subjective ratings of alertness, and objective cognitive task performance. Relevant aspects of this research are reviewed below with reference to the present study of offshore control-room operators.

1.1 SHIFTS, ALERTNESS, AND CONTROL-ROOM WORK

The present study was intended to examine changes in mood and cognitive performance among control-room operators over the course of the two-week offshore period. The work carried out by these operators, and others engaged in similar control and monitoring tasks in the production areas, is essentially similar to control-room work in onshore oil and gas installations. The work requires continuous vigilance and attention to a variety of sources of information, the capacity to make accurate judgements based on this information, alertness to potentially hazardous situations, and the ability to respond speedily and appropriately. Thus, shift schedules which give rise to subjective fatigue, and reduce alertness, speed of reaction, or the capacity to think clearly, not only impose severe demands on the personnel concerned but may also jeopardize the safety and efficiency of production processes. A recent study of process-control operators into a chemical plant found that fear of making mistakes and workload pressures were perceived as among the most stressful aspects of the work situation (Vaernes et al. 1988).

Other research, in field and laboratory settings, has focused on alertness and performance in relation to factors such as shift patterns, extended work hours, sleep loss, meals, and exposure to noise (e.g. Haslam, 1982; Rosa et al, 1985; Rosa & Colligan, 1988; Smith & Miles, 1987; Tilley et al. 1982). Topics of particular relevance to the present study, including shift duration, shift sequences and their implications for diurnal adaptation, are reviewed below.

1.1.1 Shift duration
Offshore, the typical duration of a shift is 12 hours. The reasons for adopting this shift pattern, and some of the implications for offshore work, are discussed in a document published by the International Labour Office (1980), but research into the effects of 12-hour shifts has not been carried out in the offshore environment. However, shifts of this duration are also in operation in some onshore organisations, and field studies comparing 12-hour and 8-hour shifts in the petrochemical industry (Campbell, 1980; Northrup et al. 1979), and in other organisations (see Hurrell & Colligan, 1985 for a review of this work) have been reported. The findings tend to be equivocal; in some cases, no significant differences are observed, while other studies suggest that different measures (eg work satisfaction, morale, and subjective fatigue) may be differently affected by shift duration.

Similarly, under laboratory conditions, comparisons of 12 and 8 hour shifts have not always produced consistent results. For instance, Colquhoun et al. (1968, 1969) studied cognitive performance during 12-hour and 8-hour shifts over periods of 12 consecutive days, but found few significant differences associated with the different shift durations. In contrast, Rosa et al. (1985) reported highly significant findings from a more recent study in which cognitive tests and mood ratings were used to evaluate the effects of 12-hour and 8-hour shifts on subjects engaged in data entry tasks under controlled conditions over a total work week of 48 hours. The results of this study showed that the 4 x 12-hour schedule was more fatiguing than the 6 x 8-hour schedule. This effect was apparent in significant results from cognitive tasks (mental arithmetic, and logical reasoning) and several self-report scales; the 12-hour schedule resulted in a decrease in performance and reports of increased drowsiness and lack of concentration over the course of the week, particularly at the end of the final shift, whereas this was not true of the 8-hour schedule.

The significant effects on performance and subjective fatigue found by Rosa et al. after four 12-hour day shifts serve to highlight the demanding nature of the offshore shift schedule in which 14 consecutive 12-hour shifts are worked, with the added adaptational load of a nights/days shift change at the end of the first week. Whilst longer leave periods may largely compensate for the long-term effects of intensive offshore work, the results reported by Rosa et al. suggest that short-term effects on mood and performance would be apparent. Furthermore, the environmental context in which offshore work is carried out imposes a number of demands and constraints which do not apply to onshore employees, and which would accentuate cumulative fatigue effects.

Laboratory findings demonstrating adverse effects of 12-hour shifts on cognitive performance are particularly relevant to the type of tasks carried out by control-room operators, although the nature and extent of any corresponding impairment in actual work performance is not known. Concentration lapses and subjective fatigue are potentially hazardous in process-control tasks, and accident an incident rates might serve as indicators of fatigue effects. In the onshore petrochemical industry, there seems to be little evidence of increased accident rates associated with 12-hour shifts (Campbell, 1980; Northrup et al. 1979). Among offshore employees, Cooper and Sutherland (1987) noted that 24% of their sample reported having been injured in an offshore accident on some occasion during their working life; however, only 21% of these accidents occurred between midnight and 6 a.m., marginally less than the proportion expected for a 6-hour period. Thus, there was no evidence in these data of increased frequency of accidents during the later part of 12-hour night shifts.
However, in more recent data, reported accidents did appear to be disproportionately high during the midnight to 6 a.m. period, although this finding applied only to contractors’ personnel and not to those employed by the operating companies (Sutherland, 1992, personal communication).

1.1.2 Shift Patterns

Work/rest schedules and patterns of shift changes have also been widely investigated in the research literature. These studies show that shift patterns have effects on performance, on circadian adaptation, on sleep quality and duration, and on health and well-being (Smith et al. 1982; Tilley et al. 1982; Knauth & Kiesswetter, 1987; Verhaegen et al. 1987; Wilkinson et al. 1989).

Night work tends to give rise to the most serious problems, and a number of studies have sought to determine how night work can be scheduled so as to minimise health and performance impairment. Currently, fast rotating schedules in which 2-3 day shifts are followed by 2-3 night shifts and then by an off-duty period are one recommended solution (e.g. Knauth & Kiesswetter, 1987). Longer periods of night work (21-28 days) or permanent night shifts, which allow time for circadian rhythms to adjust, are also advocated (Wilkinson et al. 1989) in some circumstances.

The least favourable schedules appear to be those in which night shifts are worked in the context of a weekly rotating pattern, usually requiring night work during one week in three. These schedules give rise to significant decrements in performance and sleep quality, and disruption of sleep stages (Tillet et al. 1982). In the longer term, weekly rotating shifts and night shifts are associated with higher rates of injuries, sickness absence days, and sleep and appetite disturbances among employees than day or afternoon shifts (Smith et al. 1982).

These findings provide some basis for recommendations about shift patterns. However, shift-work effects are complex, and no single ideal pattern exists; individual differences, demographic factors, job characteristics, and organisational factors are all relevant to shift schedule optimisation (Akerstedt & Torsvall, 1981; Anderson & Bremer, 1987; Monk, 1986; Tepas et al. 1985).

In offshore work, organisational factors are particularly relevant, and shift patterns are constrained by a number of factors that do not apply onshore. In particular, only two teams of control-room operators are on the platform at any one time; consequently, 12-hour shifts are normally worked to provide continuous monitoring and control of production processes. In these circumstances, the research literature on performance and circadian adjustment suggests that during any two-week offshore work period, the most favourable arrangement would be for individuals to work the same shift throughout the two weeks, alternating day and night shifts over successive offshore trips.

However, such an arrangement complicates the planning of schedules, and is generally not favoured by operators, who prefer to go on leave adjusted (in terms of circadian rhythms) to sleeping at night rather than during the day. Thus, the schedule widely operated offshore (and which applied during the present work) is that 12-hour night shifts are worked during the first week, changing to 12-hour day shifts for the second week. Under this system, operators typically have a break of only 2-3 hours between the end of last night shift and the start of the first day shift; thus, little or no
sleep is possible over a 24-hour period. Sleep deprivation of this duration has markedly adverse effects on sleepiness, negative mood, attentional problems, and task performance (Babkoff et al. 1988; England et al. 1985; Mikulincer et al. 1989; Wilkinson & Houghton, 1982).

It is clear from the work reviewed above that the shift schedules worked offshore are demanding of adaptational ability and resilience among the personnel concerned. While younger individuals may be able to cope adequately, older employees, who tend to find greater difficulty in adjusting to shift work (Akerstedt & Torsvall, 1981), may experience more problems; thus, the trend of increasing average age in the offshore workforce suggests that shift patterns may become an increasing source of stress in the offshore environment.

1.1.3 Present study

The present study provided an opportunity to examine the effects of offshore shift work in the light of the literature reviewed above. In particular, the research was intended to examine how the particular shift schedules worked offshore affected patterns of mood and alertness among control-room operators. The study was necessarily exploratory in nature in that no studies of mood and cognitive performance among offshore employees are reported in the research literature. However, it was possible to draw on the existing literature in choosing tasks which have been found to be sensitive to the effects of shift work, sleep loss, and fatigue. The data collection schedule was designed around the existing shift pattern, which was the same on each of the platforms on which data were collected. Thus, the present work did not provide an opportunity to examine different shift schedules; rather, it was intended to evaluate the effects of the present shift schedules, and to provide data which could subsequently be compared with data relating to other shift patterns.

2. RESEARCH METHOD

2.1 PARTICIPANTS

Offshore operators who had participated in the questionnaire survey took part in the work described here. The original intention was to include approximately 40 operators in this part of the work but, in practice, the data analysis is based on a considerably smaller sample. Some reduction in numbers occurred because operators were unable to attend some schedule test sessions, and the missing data points precluded reliable analysis of their data.

More significantly, however, three offshore visits planned for November/December 1989 were cancelled or curtailed on the grounds of lack of offshore accommodation, and/or production shut-downs resulting from storms; consequently, no data suitable for analysis were obtained from these visits. Thus, the number of data sets that could be analysed was less than half that intended. However, although the sample was smaller than ideal for this type of work, extensive data were obtained from each of the participants involved. For most analyses, either 13 or 18 individual data sets were available, depending on whether the entire two-week offshore work period (13 data sets), or only the shift-change phase (18 data sets), was examined.

2.2 EXPERIMENTAL DESIGN
A number of problems had to be taken into account in designing the data collection schedule. These problems, and the actors which influenced the design adopted, are summarised below.

- The same shift pattern was in operation on each of the three platforms concerned; within this pattern, some experimental design problems could not be entirely overcome. In particular, operators always worked a week of night shifts followed by a week of day shifts. Therefore, differences between night-shift and day-shift work were inherently confounded with differences between the first week and the second week offshore.

- Cognitive task performance tends to show learning effects with continued practice; these effects are relatively small for some tasks (e.g., simple reaction time), but larger for more complex tasks, such as those involving memory and reasoning. In the laboratory, this problem is overcome by extensive practice prior to the experiment, or by designing a data collection schedule which balances training effects over conditions. Neither of these approaches could be implemented in the present study, but some training in the cognitive tasks was provided by eliminating data obtained during the initial test shift from the cognitive performance analyses.

- Offshore shift schedules are such that a new team of operators comes on board each week coincident with the night-to-day shift change; thus, three consecutive weeks would be required to test two incoming groups through the entire two-week work cycle. In addition to the length of time required, this approach had a number of other disadvantages, including complete confounding of task practice effects with night/day shift effects.

- In terms of the time required offshore by the experimenters, it was more efficient to test both night and day shift operators during the same week. Furthermore, by extending the data collection period to 10 days (starting on a Sunday) the critical shift-change period (from Monday to Wednesday) could be included for two groups of operators.

These considerations led to the data collection schedule shown in Figure 2.2.1. It involved dividing the two-week offshore period into three 'phases' of four shifts each (one in the night-shift week; one covering the shift-change period; and one in the day-shift week). Within this framework, each participant was tested over two of the three phases; thus, one schedule covered the night-shift phase (Tuesday to Friday) and continued through the shift-change phase (Sunday to Wednesday), while the other schedule covered the shift-change phase (again, Sunday to Wednesday) and continued through the day-shift phase (Friday to Monday). This plan enabled all subjects to be followed through the shift-change phase, when sleep-loss and night/day adaptation problems were most acute. It also allowed the day and night shift phases to be included in some analyses, with partial balancing of practice effects.

It was important to examine not only changes across different shifts but also changes within shifts. Therefore, three assessments were carried out during each shift of testing; the first took place within 120 minutes of the start of the shift; the second within a 120 minute period in the middle of the shift, starting immediately after the lunch break; and the third during the final 120 minutes of the shift. As far as possible, operators attended sessions in the same order on each occasion, thus
ensuring that the intervals between test sessions were approximately the same for each participant.

In summary, therefore, for each operator participating in the work, three assessment sessions were scheduled during each of two blocks of four shifts (with a 'rest' day after the first block). Thus, in principle, 24 assessments were scheduled for each operator; in practice, one test occasion (Monday p.m. for the operators on installation A1; Tuesday a.m. for the operators on installation A2) was necessarily omitted during the shift-change period.

2.3 EXPERIMENTAL PROCEDURE

Testing was carried out away from the work area, and in conditions as quiet and undisturbed as possible; however, occasional interruptions (e.g. tannoy announcements) could not be voided. Participants were tested individually. The sequence of tasks was the same at each session; (i) mood checklist and ratings of sleep and workload; (ii) search-and-memory tasks; (iii) reaction-time task; and (iv) logical reasoning. Each test session lasted for a total of approximately 15-20 minutes.
Explanatory notes

In the data collection plan shown above, there are two test schedules, each group being tested over a total of 8 shifts (numbered 0 - 7). Schedule A started with the shift-change phase. Schedule B started with the night-shift phase and continued into the shift-change phase. In each schedule, there was one 'rest' day free of testing between the two phases.

Each shift of testing involved three assessments, carried out at the start of the shift, mid-shift (i.e. immediately after the meal break), and at the end of the shift.

This plan enabled data to be collected from all participants during the shift-change phase; the initial analyses examined the effects of time and shifts within this phase.

In addition, it was possible to combine data from the two test schedules to examine the three work phases (night shifts, shift change, and day shifts) in a continuous sequence. In this analysis, the design was balanced with respect to the comparison between the shift-change phase and the stable day/night shift phases, as shown in the diagram below.

<table>
<thead>
<tr>
<th>A</th>
<th>Shift-change phases</th>
<th>Day-shift phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Night-shift phase</td>
<td>Shift-change phase</td>
</tr>
</tbody>
</table>

Figure 2.2.1
Data collection plan: mood and performance testing

2.4 DATA ANALYSIS

Analysis of the effects of different shifts and times within shifts was carried out in two parts; the first part involved only the data for the shift-change phase (and was therefore based on the maximum sample size), while the second part extended the analysis to include the sequences of day and night shifts (for which complete data were available only for a smaller number of participants). In view of the small sample size, the analysis focused on the effects of work phases, shifts and times on the measures made; individual difference effects were not examined.
2.4.1 Shift-change phase

Data from the shift-change phase were analysed to determine the effects of shift (Sunday night, Monday night, Tuesday day, and Wednesday day) and time (start-of-shift, mid-shift, and end-of-shift) on mood and performance. In these analyses, all the participants were exposed to the same work conditions (two night shifts immediately followed by two day shifts) over the period concerned.

Repeated measures analyses of variance were used to evaluate the effects of shifts and times. For the mood data, the analysis took a 4 x 3 form (4 shifts x 3 time-within-shift levels), while for the performance measures (for which the data from the first shift were omitted to allow for task familiarisation), it took a 3 x 3 form (3 shifts x 3 time-within-shift levels). Differences between different locations and between separate shift teams were also examined in these analyses, and where such differences were found, these results are also reported.

2.4.2 Night shifts, shift-change, and day shifts compared

The data also allowed extended analyses to be carried out in which the shift-change phase was compared with the 'stable' phase of day or night shifts. In these analyses, changes over the entire two-week offshore period were examined as a continuous sequence, although separate groups of operators (overlapping during the shift-change phase) were involved. This analysis allowed a more complete examination of different phases of the two-week offshore work cycle, although the number of operators for whom adequate data were available was smaller than that for the shift-change phase.

The analyses were based on a four-factor design, which allowed evaluation of effects associated with phase (i.e. night-shift phase, shift-change phase, and day-shift phase); shifts (i.e. the particular shift in a four-shift sequence) and, time-within-shift (start-of-shift, mid-shift, and end-of-shift). In order to remove overall differences between operators assessed over different phases, the analysis was statistically controlled to equate the groups on the average level of scores during the shift-change period (during which work conditions were the same for both groups) but this statistical procedure did not influence any other aspects of the analysis.

2.4.3 Treatment of missing data

The shift-change phase gave rise to missing data either for the end-of-shift assessment on Monday night (on platform A1), or for the start-of-shift assessment on Tuesday (on platform A2). These times coincided with the short break operators took before starting the day shift. The simplest solution to the analysis problems created by these missing data was to estimate missing values by taking the average of the assessments immediately prior to, and immediately following, the missing point. This method had the advantage of allowing data from both platforms to be analysed together. As a check on the validity of the estimates, some analyses were repeated using more complex statistical methods, applied separately to the A1 and A2 data. These analyses indicated that no serious distortion was introduced by the estimation methods used.
3. MOOD CHANGE

3.1 BACKGROUND

Self-report rating scales were used to assess alertness and other mood states at different times within shifts, and on different shifts within the three work phases. Mood scales of this kind have been widely used for examining patterns of subjective well-being in relation to shift work, and work-related stressors more generally (e.g. Baddeley, 1981; Mikulincer et al. 1989; Rose et al. 1985; Stollery, 1986).

3.2 PROCEDURE

At the start of each assessment session, subjects completed a short questionnaire which included the mood rating scales and also covered the following topics: details of sleep duration and quality during the previous sleep period and use of sedative medication, if any (start of shift only); meals, and consumption of tea or coffee; and perceived workload.

The mood ratings were made on 12 scales, relating to three mood states (alertness, anxiety, and depressed mood). For each scale, subjects indicated their current state by marking a linear scale, anchored at either end by opposing mood adjectives (see Figure 3.2.1). The scales were balanced; six adjective pairs had the positive mood at the left, and the remaining six had the positive mood at the right. Different orders of presentation were used at different times of day. The position of the response along the scale (reversed as appropriate) was used as the rating for that particular mood state.

3.3 PSYCHOMETRIC ANALYSIS

Factor analytic methods were used to determine the number of mood dimensions which could be distinguished in the data. To ensure sufficient sets of data (for statistical reasons only the first set of ratings from each individual could be included in this analysis), onshore operators participating in the survey research described in Part I of this report also filled in a single mood questionnaire for use in these psychometric analyses.

It was found that although three types of mood adjectives were included in the checklist, only two dimensions could be identified in the data set. The four items relating to the alertness-fatigue dimension formed one scale, while the remaining eight items formed a second scale assessing relaxed/cheerful versus tense/miserable. These results parallel literature findings of two primary dimensions of mood, relating to arousal and stress (e.g. King et al. 1983). In the present study, the two scales (labelled 'alertness' and 'positive mood') were analysed separately, but the dimensions were moderately inter-correlated, indicating that there was a tendency for reports of greater alertness to be associated with reports of more positive mood. As computed in the present work, the maximum possible range of scores on each of the two mood scales was from -5 (fatigue / negative mood) to +5 (alertness / positive mood).
In the actual questionnaires, the scale length was 10 cm.

1 Indicates the high-scoring end of the four scales which were summed to form the alertness dimension.

2 Indicates the high-scoring end of the eight scales which were summed to form the positive mood dimension.

Figure 3.2.1
Assessment of alertness and positive mood

3.4 RESULTS

The results from the two sets of analyses are presented in the following sections. The first section examines the effects of shifts and time-of-shift on mood across the shift-change phase, while in the second section changes in mood and other self-report measures across the two-week work cycle are examined.
3.4.1 Analysis of mood during the shift-change phase

- **Alertness.** Analysis of the data for the four successive shifts of the shift-change phase showed highly significant effects of shift, $F = 16.1, \text{df} = 3.39, p < .0001$, and of time within shift, $F = 14.7, \text{df} = 2.26, p < .0001$. In addition, the interaction term (shifts x time) was significant ($F = 2.97, \text{df} = 6.79, p = .012$) indicating that the pattern of change in alertness over the course of a shift was different for the four shifts in the sequence. Data from 18 operators were included in these analyses; there was no overall difference between platforms in the effects observed. Mean alertness levels are shown graphically in Figure 3.4.1. in relation to shifts and time-of-shift.

![Figure 3.4.1
Mean alertness levels over the shift-change phase](image)

In general, alertness decreased in a near-linear manner from the start to the end of shifts; this effect was most marked on the Monday night. Only for the Tuesday day shift, during which alertness was uniformly low, did this pattern not apply. Thus, the effects of having little or no sleep between the Monday night shift and the Tuesday shift were clearly apparent in
self-reports of low alertness, which persisted throughout Tuesday, and continued in a less marked form during Wednesday.

Further analyses demonstrated that the effects of shifts and time-of-shift on alertness were not substantially altered by taking into account concurrent changes in positive mood. Thus, the effects observed for alertness were significant over and above the more generalised positive responses common to both alertness and positive mood. There was also no evidence that the changes in alertness ratings were associated with reported workload levels during the work period concerned.

- **Positive mood.** Scores on the measure of positive mood were analysed in the same way as those for alertness. These analyses showed that subjective ratings of positive mood followed a similar pattern as those for alertness, but the effects were much less marked. These weak effects were not found to be significant over and above those observed for the alertness-fatigue scale. Thus, there was no specific effect of shifts or time of shift on positive mood when changes in levels of alertness were taken into account.

### 3.4.2 Mood, sleep, and workload, over the three work phases

The analysis method described above was extended to take into account the data relating not only to the shift-change phase, but also data for the night-shift and day-shift phases. Combining data from the two data collection schedules (see Figure 2.2.1 in Section 2.2), a sequence of three blocks of four shifts covering the two-week offshore work cycle was examined. The analyses were based on a four-factor design; ‘shifts’ and ‘time-of-shift’ accounted for two factors, while the different shift sequences tested accounted for the other two factors. Thus, this analysis examined the extent to which changes in mood depended on (a) the particular shift in a four-shift sequence; (b) time-within-shift; and (c) whether the sequence was night-shift phase, shift-change phase, or day-shift phase.

Similar analyses were also carried out on reported sleep hours, and on ratings of sleep quality, although for these measures, the time-of-shift factor was not relevant as there was only one report for each shift. In addition, the workload ratings made at the mid-shift and end-of-shift assessments were analysed; thus, in this case, the time-of-shift factor had two levels relating to the first and second half of each shift respectively. These analyses (based on data from 13 operators) allowed the patterns of responses for each of the five measures (alertness, positive mood, sleep duration, sleep quality, and workload) to be examined. In the following sections, the results are shown graphically with values plotted to reveal the patterns of effects over three phases of the work cycle. The statistical results (in terms of the significance levels of the relevant terms in the analyses) are summarised in Section 3.4.3.
• **Alertness.** There were significant overall differences in alertness during the shift-change phase as compared with the nights/days phases, day shifts showing the highest overall level of alertness. However, the more important finding from these analyses was that the pattern of changes across shifts depended on the phase concerned. Time of shift was also a significant factor, alertness falling from the start to the end of a shift, during almost all shifts. There was also evidence that the pattern of alertness change during shifts varied across phases, and across the four-shift sequences within phases.

These results are shown graphically in Figure 3.4.2. During the night-shift phase, reported alertness fell sharply during each shift, but tended to increase across shifts in a linear manner as operators became more adapted to night-shift work. These improving levels of alertness were greatly disrupted during the shift-change phase, alertness being particularly low during the Tuesday shift. Alertness tended to be less variable (both across shifts and during shifts) for the day-work phase than for the other work phases. Furthermore, the mean level of alertness during day shifts was roughly comparable with the highest levels shown during the night-shift and shift-change phases.

![Figure 3.4.2](image)

*Figure 3.4.2*

Mean alertness levels across each work phase.
**Positive mood.** The measure of positive mood showed a significant effect of time of shift; this effect was independent of phases or of shifts within the four-shift assessment sequence. The data showed that positive mood was highest at the start of the shift and decreased in a roughly linear manner during the shift. However, this effect was not significant after changes in alertness had been taken into account; it appeared therefore that the reduction in positive mood over the course of a shift was directly associated with the decrease in alertness.

- **Sleep duration.** The overall tendency for sleep duration to differ across phases was reflected in the marginal significance of the overall effect of phases. However, a much stronger effect reflected the serious disruption of sleep patterns associated with the Monday-Tuesday shifts during the shift-change phase, and the different patterns for night and day shifts. These effects are clearly evident in Figure 3.4.3, which shows the reported duration of sleep over each shift sequence. Sleep duration prior to the first night shift was relatively short; in addition to adaptation problems, travel time and time of arrival at the platform are relevant in this context. Compensating for this initial sleep loss, the three subsequent daytime sleep periods are relatively long, as are the two immediately preceding the Monday-Tuesday change to day shifts. Following the shift-change, sleep duration stabilises again, but at a generally lower level than during night shifts, thus tending to confirm the pattern found in the questionnaire survey.

- **Sleep quality.** As also shown in Figure 3.4.3, results relating to sleep quality followed a pattern very similar to that for sleep duration; an initial phase of improvement across shifts (which in this case took an almost linear form), was followed by a period of disruption across the Monday-Tuesday shift change, and then by relative stability of sleep quality over the day shift phase. As compared with the sleep quality data obtained from the questionnaire survey, the ratings obtained in this part of the research suggested that night shift sleep quality was worse, and day shift sleep quality was better, than that reported in the questionnaire.

- **Workload.** The most marked effect on workload was the difference between different phases; perceived workload was lowest during the shift-change phase, and highest during day shifts (see Figure 3.4.4). However, the marginal significance (p=0.06) of the ‘phases x shifts x time-of-shift’ term suggested that, over and above the differences between phases, workload varied in an unpredictable manner from morning to afternoon (or the equivalent during night shifts), and from shift to shift. This finding is consistent with the fluctuating nature of control-room work and, more particularly, with the occurrence of occasional short-term production problems which may necessitate plant shut-down with consequent transient increase in workload.
Figure 3.4.3
Sleep duration and sleep quality across the work phases

The shaded lines indicate test shifts in the night-shift week.
The dotted lines indicate the level reported in the survey (see Part I).
Combined analysis of mood and sleep measures. By re-analysing the alertness scores taking into account reports of sleep duration and quality, it was possible to examine the extent to which sleep patterns accounted for changes in self-reported alertness. The results suggested that short sleep duration and poor sleep quality associated with the shift-change phase accounted statistically for the marked fall in alertness over the following days, thus demonstrating empirically the direct link between sleep and alertness.

3.4.3 Summary of statistical tests for mood, sleep, and workload

Table 3.4.1 summarises the results of the statistical tests (taken from the analyses of variance) from which the findings described in Section 3.4.2 were derived.
Table 3.4.1
Summary of statistical tests of the effects of work phases, shifts and time on measures of mood, sleep, and workload

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Phases</td>
<td>Shifts x phases</td>
<td>Time of shift</td>
<td>Time x phase</td>
<td>Time x shifts x phases</td>
</tr>
<tr>
<td>Alertness</td>
<td>F 6.54</td>
<td>7.00</td>
<td>16.84</td>
<td>ns</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td>df 1.11</td>
<td>3.33</td>
<td>2.22</td>
<td>ns</td>
<td>6.66</td>
</tr>
<tr>
<td></td>
<td>p &lt;.03</td>
<td>&lt;.001</td>
<td>&lt;.001</td>
<td>ns</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Positive mood</td>
<td>F</td>
<td></td>
<td>5.39</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td>df ns</td>
<td>ns</td>
<td>2.22</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>p</td>
<td>ns</td>
<td>&lt;.02</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Sleep duration (hours)</td>
<td>F 3.90</td>
<td>23.63</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>df 1.11</td>
<td>3.33</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>p &lt;.07</td>
<td>&lt;.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleep quality</td>
<td>F</td>
<td></td>
<td>10.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>df ns</td>
<td>3.33</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>p</td>
<td>ns</td>
<td>&lt;.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workload</td>
<td>F 9.58</td>
<td></td>
<td></td>
<td></td>
<td>2.68</td>
</tr>
<tr>
<td></td>
<td>df 1.11</td>
<td></td>
<td></td>
<td></td>
<td>3.33</td>
</tr>
<tr>
<td></td>
<td>p .01</td>
<td></td>
<td></td>
<td></td>
<td>&lt;.07</td>
</tr>
</tbody>
</table>

*ns = non-significant NA = not applicable

1. **Phases** refers to overall differences between the shift-change (S-C) phase and the night/day shift phases.

2. **Shifts x phases** refers to whether the pattern of results for a four-shift sequence differs in different work phases.

3. **Time of shift** refers to the overall effect of time of shift (start-of-shift, mid-shift, end-of-shift) irrespective of phase or shift sequence.

4. **Time x phase** refers to whether the effects of time-of-shift differ in different work phases.

5. **Time x phase x shifts** refers to whether the effects of time of shift differ in different phases and different shifts within phases.
4. COGNITIVE PERFORMANCE

Three tasks were used to assess the extent to which participants were able to concentrate, and to process information speedily and accurately, at different times, and during different shifts in the two-week work cycle. These tasks were chosen to reflect in a simplified form a number of cognitive operations relevant to the performance of control tasks. Findings from each task are described below, and the statistical tests are summarised in Section 4.4.

4.1 REACTION TIME

4.1.1 Background

A simple reaction time task (i.e. a task with a single stimuli requiring a single response) was included in the test battery for two reasons. First, it has been shown to be sensitive to the effects of fatigue in shift work (Tilley et al. 1982; Wilkinson et al. 1989). Second, the training time for this task is relatively short (Wilkinson & Houghton, 1982): this was an important consideration as it was not possible to train participants extensively prior to data collection, and nor was it possible to design a study which fully controlled for training effects.

4.1.2 Procedure

The reaction time task was presented by means of a portable computer. Subjects were asked to respond as quickly as possible (by pressing the keyboard spacebar) to a single target stimulus which appeared on the screen following a ‘warning’ signal. The warning signal was the appearance of a 3 cm. open square on the screen; the target signal was a small bright rectangle which appeared subsequently in the centre of the warning square. The delay between the warning signal and the target stimulus varied randomly between 2 and 10 seconds; thus, the exact time at which the target appeared on each trial was unpredictable. Both the warning signal and the target stimulus appeared in the same position on each trial. The reaction time recorded by the computer was the elapsed time between the appearance of the target signal and the operation of the response key. A set of 50 trials were presented during each test session.

4.1.3 Data processing

Data from this test was output from the computer in the form of reaction times for each of the 50 trials, together with the length of the interval between the warning signal and the target for each trial. Overall mean reaction time for each block and for the entire series of 50 trials was also recorded.

For the purposes of analysis, it was necessary to scan each set of data to identify and remove values which were outside the statistical normal distribution of responses for that individual during that session, either because the subject had anticipated the response (leading to an unrealistically short response time), or because an unusually long time had occurred through an external distraction or attentional lapse, or through response error (e.g. fingers slipped off the response key). The usual criterion for identifying ‘outlier’ of this kind is that the reaction times are more than 2 standard deviations from the mean for the set of trials concerned, and this criterion was adopted in screening the data in the present work. Participants differed in the
number of such outliers identified; some had none at all, while in a few cases as many as 4-6 data points in a set of 50 were outside the distributional pattern. The data used in the analysis were the overall mean reaction times after 'outliers' (if any) had been eliminated.

4.1.4 Analysis of reaction times over shift-change phase

Sufficiently complete data covering the shift-change phase were available for a total of 18 operators. The analyses were carried out separately for two groups. The first group consisted of 8 operators from A2; the second group consisted of 10 operators (one shift team from A2, and some members of two shift teams from A1). Carrying out two separate analyses served to remove any effects due to the slightly different form in which the experimental task was presented in the two groups. The second analysis also allowed examination of any differences between the two platforms (resulting for instance from different testing conditions). To ensure a minimal level of training for all subjects, in both cases, data from the first shift of the four-shift sequence were excluded. Thus, the form of the analysis was 3 (shifts) x 3 (time-of-shift).

- In the first set of data (relating to 8 operators on A2), the effect of time-of-shift was highly significant, F(2,12)=8.75, p<.005, while the effect of shifts was marginally significant ( p<.08). There was no interaction between shifts and time, indicating that the pattern of results over different shifts did not differ significantly. For each group, reaction times were lowest for the Monday night shift, and increased successively on Tuesday and Wednesday. In addition, there was a consistent pattern within each shift; reaction time was highest immediately following the meal break and decreased again at the end of the shift. The results are shown graphically in Figure 4.1.1. There were no significant differences between the two shift teams shown in Figure 4.1.1, either in the overall levels of reaction times (which were consistent with published data for this task, e.g. Wilkinson & Houghton, 1982), or in the pattern of relationships between shifts, time of shift, and reaction times.

- Analysis of the second data set (relating to 10 operators), showed a weak effect of shifts, and also a weak interactive effect suggesting that the effect of time-of-shift tended to differ for the three shifts included in the analysis. However, both these effects reached only marginal significance levels (p<.10 in each case). There were no significant differences between operators located on different platforms, either in overall levels of performance or in the patterns of relationships over shifts/times. Examination of the data revealed greater variability, and a less consistent overall pattern, than was found for the first group, although there was similar evidence of long reaction times for the first two assessments on the Tuesday shift-change day.
Figure 4.1.1
Mean reaction times over the shift-change phase for two shift teams
4.1.5 Analysis of reaction times over the three work phases

Reaction times were further analysed by combining data from the three work phases, in the same way as described in Section 3.4.2 for the self-report data (with the exception that data from the first shift in each sequence were omitted to allow for initial training effects). These analyses were carried out separately for two groups; the eight operators on A2, and the 5 operators on A1 (data for the entire sequence were available only for these 13 operators). The results for each installation are outlined below, and data from the larger group (A2) are shown graphically in Figure 4.1.2.

- A2 platform. In this analysis, the night-shift, shift-change, and day-shift phases gave rise to significantly different patterns of reaction times across the three assessment occasions during each shift. It can be seen from Figure 4.1.2 that there is a characteristic pattern of changes within shifts during each phase. Thus, during night shifts, reaction times tended to be lowest at the mid-shift assessment, and to increase at the end of the shift.
However, by the Monday night shift, the pattern characteristic of the shift-change phase had begun to appear with highest reaction times being recorded at the mid-shift assessment. This pattern persisted into the day-shift phase, but became less marked as adaptation progressed, until the final day of the sequence (the last full shift before the operators concerned went on leave), when unexpectedly high readings were obtained in the second half of the shift.

- **A1 platform.** The results showed a significant effect whereby the overall average reaction time was markedly higher in the shift-change phase, than during day or night shifts. However, there were no significant effects of time-of-shift, or of shifts within the three-shift sequences.

### 4.2 LOGICAL REASONING TASK

#### 4.2.1 Background

The logical reasoning test assesses ability to think clearly and rapidly in manipulating information; it has been shown to be sensitive to the effects of noise (Smith, 1985); sleep deprivation (Babkoff et al. 1985; Babkoff et al. 1988); diurnal changes (Folkdar et al. 1983; Englund et al. 1985); 12-hour workdays (Rosa & Colligan, 1988); and other stressors (Logie & Baddeley, 1985; Stollery, 1986). The test consists of a sequence of grammatical statements (for example, ‘B does not follow A’), each of which precedes a letter pair, AB or BA. The subject's task is to decide as quickly as possible whether each statement is true or false of the letter pair which follows it.

The test sequence incorporates four different types of statements: active positive (e.g. ‘A follows B’); active negative (e.g. ‘B does not follow A’); passive positive (e.g. ‘B is followed by A’); and passive negative (e.g. ‘A is not followed by B’). Using all combinations of A and B pairings, 8 different items can be derived for each type of statement. The different types of statements vary considerably in difficulty according to the nature of the cognitive manipulation required to arrive at the correct response. In general, negative items are more difficult than positive ones, and passive items are more difficult than active ones.

#### 4.2.2 Procedure

Subjects were presented with a random sequence of 32 AB statements (8 of each type); the statements were computer-generated and randomly ordered. Each statement appeared on the screen separately, together with the letter pair, AB or BA. The subject responded by pressing the appropriate key (two specific keys on the keyboard were designated ‘true’ and ‘false’ respectively). As soon as one response had been made the next statement appeared on the screen until the entire sequence had been completed.

#### 4.2.3 Data processing

A computer program analysed each set of results, producing scores for average time for correct and incorrect responses to each type of statement. In addition, the proportion of correct responses was recorded for each type of statement. The program also compiled the sets of data for each test session into single data files for
analysis purposes. Inspection of the data showed that overall accuracy levels were high (90-05%) after initial familiarisation with the task; therefore, in the results presented below, the measure analysed was the average time taken for correct responses to each type of item.

4.2.4 Analysis of logical reasoning responses over the shift-change phase

Initial analyses of response times revealed practice effects in the data, whereby overall response times tended to decrease across a sequence of trials irrespective of work conditions. These effects complicated the detailed analyses, although the comparison of overall performance in the shift-change phase with performance in the nights/days phases was balanced for practice effects. It was not possible, however, to control for practice effects across the course of each shift, or across the shifts in each phase. In the statistical analysis, therefore, the aim was to identify the effects of shift sequences and time-of-shift against a trend of continuing performance improvement.

Data covering the shift-change phase were available for 17 operators. A four-factor analysis of variance was carried out. The two work factors were shifts and time-of-shift. The other two factors related to the difficulty of the AB task. Two aspects of difficulty were considered; negative versus positive statements, and active versus passive statements.

The results showed an overall difference between the three shifts, consistent with a general improvement due to practice, and an overall difference between positive and negative statements. More importantly, however, the three-way interaction term 'shifts x time x negative/positive statements' was significant; this result indicated that the effects of shifts and time-of-shift on speed of response was different for negative and positive items.

The results, showed the expected overall difference in response times for positive items and negative items (see Figure 4.2.1). For the positive items, performance was relatively constant over the sequence of days and shifts, indicating that for these items the combined effects, if any, of practice and shift conditions produced stable performance levels. In contrast, for the more difficult negatively-worded items, results for the Monday night shift showed a pattern consistent with improvement due to practice, but this pattern was interrupted on Tuesday with the switch to day shifts. The results for Tuesday suggest that fatigue not only suppresses the improvement expected from continued practice, but actually reverses it, with successively longer response times throughout the day. On the following day, response times decrease as compared with Tuesday, but again there is little effect of increased practice through the day.

4.2.5 Analysis of logical reasoning response times over the three work phases

An extended analysis of the data from the AB task was carried out in which the three phases (nights, shift-change, and days) were examined in addition to shifts and times. The task-difficulty factors (positive/negative items, and passive/active items) were also included in these analyses. The results of the analysis revealed no overall differences between the shift-change phase and the nights/days phases. Instead, a
complex pattern of findings emerged in which a significant overall effect of shifts (\(F=7.05, \text{df}=2,22, p<.005\)) reflected strong practice effects across the test sequences. However, there was also a significant interaction which indicated that the patterns of results across shifts and times were different for the shift-change phase as compared with the nights/days phases.

Levels of task difficulty were also involved in this interactive effect. Further analyses indicated that speed of response for more difficult items (in this case, the passive-worded items) was adversely affected by the shift-change phase (and particularly at the end of shifts during this phase) relative to response speed during the corresponding days of the night or day shifts. This effect was not observed for the easier (active-worded) items.

Figure 4.2.1
Mean response times for the logical reasoning task across the shift-change phase
4.3 SEARCH-AND-MEMORY TASKS

4.3.1 Background

The search-and-memory (SAM) tasks required subjects to search for one or more target letters in an array of non-target letters. Both versions of the task (designated SAM-1 and SAM-5) involve information-processing under conditions requiring both speed and accuracy. In addition, the SAM-5 task involves multiple target letters, adding a memory load to the search task. Experimental evidence indicates that SAM tasks are sensitive to various aspects of work stress, including noise, shift work and meals (Folkard et al. 1976; Smith & Miles, 1987). In addition, changes in SAM performance over the course of a workday has been found to be influenced by objective level of workload (Parkes, unpublished data).

4.3.2 Procedure

The SAM-1 and SAM-5 tasks were presented in paper-and-pencil form. In the SAM-1 task, subjects searched a series of one-line sequences of 60 random letters marking the occurrence of a previously memorised single target letter, shown at the start of each line. They were instructed to memorise the target letter, and then search the line without further reference to the target letter and without going back along the line after searching it once. Each line had to be searched fully even if a target had already been detected, as some lines included more than one occurrence of the target letter.

A different test sheet was used at each session, with order effects balanced across individuals. The time taken to complete each sheet was recorded with a stop-watch, and used as the measure of performance speed. Accuracy was calculated as the proportion of available targets correctly marked.

In the SAM-5 task, subjects were asked to memorise a set of five target letters at the start of each line of 60 random letters, and to check the line without further reference to the target letter set. The target letters appeared singly in the random letter sequences, and subjects were asked to mark the occurrence of any one of them. This task took longer than SAM-1, but was carried out under similar conditions; speed and accuracy scores were again calculated.

4.3.3 Results

In the analysis of the SAM task data, the effects of continued practice at the tasks was apparent throughout the schedule of assessments. Thus, the analysis problems were similar to those described for the logical reasoning task, i.e. to identify the effects of shift sequences against a trend of general performance improvement. For these tasks, it was necessary to examine not only speed but also accuracy of performance. (Average accuracies at different assessments were in the range 90-100% for the SAM-1 task, and 55-85% for the SAM-5 task). The SAM-1 and the SAM-5 results were included in the same analysis, with task difficulty one of the factors examined. Thus, the analysis took a similar form to that used for the logical reasoning task.
Analysis of SAM data over the shift-change phase. The analysis of the data relating to the shift-change phase showed only the expected difference in performance between the two levels of task difficulty, SAM-1 and SAM-5. There were no significant effects of shifts or of time on either the speed or the accuracy measures.

Analysis of SAM data over the three work phases. The extended analysis of data from the three work phases showed no significant effects of phases, shifts, or time-of-shift on the speed with which the SAM tasks were completed. However, the analysis of accuracy scores (arcsine transformed as required for the analysis of proportions) showed a significant interaction effect (p<.04) which indicated a difference in accuracy levels between the shift-change phase and the nights/days phases. Accuracy was highest during the shift-change phase, and lowest during day shifts. This result was found for both levels of task difficulty, although the effects tended to be more marked for the memory load task (SAM-5) than for the simpler search task (SAM-1). These effects did not appear to be accounted for by 'speed/accuracy tradeoff' i.e. higher accuracy achieved at the expense of slower speed. Thus, it appears that, in response to fatigue associated with the shift-change phase, operators changed their search strategies in ways which improved accuracy in the more difficult search task.

4.4 SUMMARY OF STATISTICAL TESTS FOR PERFORMANCE MEASURES

The results of the statistical tests of the cognitive performance measures, on which the findings described above are based, are summarised in Table 4.4.1. These results were taken from the analyses of variance carried out on the performance measures.
### Table 4.4.1
Summary of the statistical tests of the effects of work phases, shifts, and times on performance measures

<table>
<thead>
<tr>
<th></th>
<th>1 Phases</th>
<th>2 Time of shift</th>
<th>3 Task level</th>
<th>4 Time x phase</th>
<th>5 Time x shifts x phases</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reaction time task</strong></td>
<td>F</td>
<td>ns</td>
<td>6.52</td>
<td>5.23</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>df</td>
<td>ns</td>
<td>2.12</td>
<td>NA</td>
<td>2.12</td>
</tr>
<tr>
<td></td>
<td>p</td>
<td>&lt;.02</td>
<td>&lt;.02</td>
<td>&lt;.025</td>
<td></td>
</tr>
<tr>
<td><strong>Logical reasoning task</strong></td>
<td>F</td>
<td>ns</td>
<td>91.37</td>
<td>6.04(^1)</td>
<td>2.72(^2)</td>
</tr>
<tr>
<td></td>
<td>df</td>
<td>ns</td>
<td>ns</td>
<td>1,11</td>
<td>2,22</td>
</tr>
<tr>
<td></td>
<td>p</td>
<td>&lt;.001</td>
<td>&lt;.01</td>
<td>&lt;.05</td>
<td></td>
</tr>
<tr>
<td><strong>SAM tasks (accuracy)</strong></td>
<td>F</td>
<td>5.76</td>
<td>80.83</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>df</td>
<td>1.9</td>
<td>ns</td>
<td>1.9</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>p</td>
<td>&lt;.04</td>
<td>&lt;.001</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*ns = non-significant  NA = not applicable

1. This result related only to active-worded items
2. This term also involved the task difficulty variable

1. **Phases** refers to overall differences between the shift-change (S-C) phase and the night/day shift phases.

2. **Time of shift** refers to the overall effect of time (start, middle, or end of shift) irrespective of phase or shift sequence.

3. **Task level** refers to the difficulty of the task, when two or more versions (or items of different kinds) were presented.

4. **Time x phase** refers to whether the effects of time-of-shift differ in different work phases.

5. **Time x phase x shifts** refers to whether the effects of time of shift differ in different phases and different shifts within phases.
5. CONCLUSIONS

The results of the present study demonstrated significant changes in alertness and cognitive performance over the course of the two-week offshore work cycle; these effects were associated with different phases in the cycle, with different shifts, and with different times during shifts. The effects on self-reported alertness, and on sleep quality and duration were clearly evident and patterns of changes in cognitive performance, particularly reaction times, were also significant.

As would be expected, the most marked and disruptive effects on mood and performance occurred over the shift-change phase; this phase was characterised by sleep loss, low alertness, and slowing of cognitive performance. While some degree of adaptation to night-shift work occurred during the first week offshore, changing from night to day shifts at the end of this first week necessitated a reversal of the adaptation process. Thus, the pattern of results obtained represented the combined effects of several inter-related factors which influence performance during irregular working hours. In general terms, these factors have been identified as (i) the state of the circadian system; (ii) the degree of adjustment to the changed sleep/wake pattern; and (iii) the degree of recovery from fatigue, especially recovery due to sleep (de Vries-Griever & Meijman, 1987). Thus, in the present study, physiological and environmental influences on the circadian system; shift sequences and the 12-hour shift duration; sleep loss; and prolonged work over the shift-change phase, were all implicated in the effects observed.

As discussed below, the broad findings of the present work were consistent with published literature relating to alertness, performance, and circadian rhythms. In general, the patterns of results from the two different platforms and the different shift groups were similar, although the groups concerned were too small for detailed comparisons. Results relating to the three separate phases of the work cycle (night shifts, shift-change, and day shifts) are reviewed below with reference to relevant published findings.

5.1 NIGHT SHIFTS

5.1.1 Alertness and sleep patterns

During the first week of the offshore work period, operators are assigned to night shifts, commencing work within a few hours of arriving on the platform. It would be expected that some degree of circadian adjustment would occur during this night-shift week, although the circadian system takes more than a week to adjust fully to a 12-hour change in routine (Monk & Tepas, 1985). Several measures, particularly the alertness and sleep data, showed patterns consistent with progressive adjustment to night work over the week.

In particular, a pattern of linear increase in mean alertness levels was apparent over the four shifts (Tuesday to Friday) in the night-shift phase. However, there was also a highly significant effect, apparent within each shift, of alertness falling sharply during the course of the 12-hour work period. Thus, each night, operators felt less alert at the end of the shift than at the beginning, although mean alertness improved over the four night shifts in the test sequence.
Reported sleep quality also improved over the night-shift sequence, following a pattern of linear increase similar to that for alertness. In contrast, sleep duration averaged almost 7 hours per day during the night-shift phase from the first day of sleep (Wednesday) onwards. The last two daytime sleep periods (Sunday and Monday) showed similar sleep durations. These data agreed well with the data from the larger-scale questionnaire survey (described in Part I of this report). The findings are of interest as the survey showed that, for night-shift work, offshore personnel reported longer sleep hours, and marginally better sleep quality, than those onshore.

In many respects, offshore work conditions are more demanding than those onshore; however, in terms of promoting adjustment to night work, the offshore environment has advantages in terms of social and physical conditions which facilitate circadian adaptation. Two aspects of offshore work are important in this context.

- The offshore environment routinely accommodates round-the-clock activity; meals, and social and recreational activities are planned accordingly. Furthermore, the need for daytime sleep for those working night shifts is accepted, and attempts are made to reduce noise and other disturbances in accommodation areas. In contrast, onshore shift-workers are much more likely to be disturbed by normal domestic activity during daytime sleep. Thus, offshore platforms are analogous to ‘company towns’ where shift work is the rule rather than the exception, and social and community life is arranged accordingly; in these circumstances, as Wedderburn (1967) noted, shift work is better tolerated than elsewhere.

- Offshore sleeping accommodation rarely has windows. This is potentially relevant in view of research (Czeisler et al. 1990) suggesting that exposure to intermittent daylight tends to impair daytime sleep and delay diurnal adaptation. These researchers found that an initial period of exposure to bright artificial light followed by sleep in a room closed to all sunlight, significantly speeded adaptation to night-shift work. Thus, the windowless accommodation provided for offshore personnel may partially explain why they experience better daytime sleep than their onshore counterparts.

In these respects, offshore work conditions provide appropriate time cues or ‘zeitgebers’ (or suppress inappropriate ones) for night-shift workers in ways which do not apply onshore. Hence, offshore conditions may facilitate speedier adjustment to night-shift work. However, it should also be noted that there are large individual differences in sleep patterns. These individual differences, which influence alertness during work hours (Anderson & Bremer, 1987) and adjustment to shiftwork (e.g. Costa et al. 1989; Moog, 1987) contributed to the variability in the present data. The small size of the present sample did not allow individual difference effects to be examined, but informal comments tended to confirm the view that some operators coped better than others with night-work and shift changes.
5.1.2 Cognitive performance

The patterns of subjective alertness outlined above were partially reflected in the reaction time measures for the night-shift phase. The most conspicuous feature of the results was the high reaction time values at the end of the Thursday and Friday night shifts. These slow reactions were consistent with the pattern of low alertness at the end of each shift; however, in contrast to the alertness data, the reaction time data showed little evidence of increasing adaptation over the sequence of night shifts. The appearance of slow reaction times after a series of night shifts is in agreement with data reported by Wilkinson et al. (1989), who found a similar pattern for nurses working a week of night shifts in a rotating shift pattern. Wilkinson et al. attributed this effect to cumulative sleep loss over the night-shift sequence, but among offshore workers, impaired sleep quality during the night-shift phase was more apparent than sleep loss per se.

The other two cognitive tasks (logical reasoning and SAM tasks) showed more complex effects over the night-shift phase, and practice effects tended to complicate the interpretation of the data. Nonetheless, for the simpler logical reasoning items (which were less markedly influenced by practice), the high response times observed at the end of the Thursday and Friday night shifts reflected the pattern of results found for reaction times.

5.2 SHIFT-CHANGE PHASE

The shift-change phase included the last two night shifts of the first week offshore, and the first two day shifts of the second week; it therefore covered the 24-hour period during which operators worked almost continuously with a break of only a few hours between the night and day shifts.

5.2.1 Alertness, sleep, and workload

Lack of sleep between the Monday night and Tuesday day shifts was clearly evident from the records of sleep duration and quality; on average operators reported two hours sleep between shifts. However, some operators had no sleep at all, thus experiencing 24 hours of sleep deprivation by the time they completed the Tuesday shift. Not surprisingly, therefore, both alertness and performance on Tuesday reflected fatigue effects.

Lowest levels of alertness were recorded on Tuesday; some improvement occurred on Wednesday morning but alertness scores fell again in the evening. The low alertness on Tuesday was consistent with data presented by Monk and Tepas (1985). These data show that during the first 24 hours of sleep deprivation, body temperature is at a minimum after 18 hours, and that minimal levels of subjective alertness occur at the same time (in practice, between 15 and 21 hours); this time period corresponds to the afternoon of the Tuesday day shift. Also of interest was the fall in alertness during the Monday night shift relative to the previous two shifts; it appeared that feelings of fatigue during the first 12 hours of the 24-hour work period anticipated the demands of continued work during the second 12 hours of this period.
In the longer-term, the present data suggest that changing shifts after one week offshore results in several days of impaired alertness relative to the levels achieved at the end of the night-shift phase; although alertness had improved substantially by the Friday day shift, it was not until the following Sunday that mean alertness levels returned to the highest level recorded during the night-shift phase. Thus, levels of alertness during day shifts appeared to show adverse effects of prior adaptation to night-shift work and the demands of the shift change, rather than cumulative fatigue effects of the two-week offshore period.

Control-room operators and supervisors are of course aware of the low alertness which occurs during shift-change days; one form of coping is to avoid initiating any unnecessary work at this time. This response was reflected in the workload ratings which were significantly lower during the shift-change phase than during the night/day shift phases.

5.2.2 Cognitive performance

Separate analyses of data for two groups of operators indicated that in both groups mean reaction times were slower during the shift-change phase than during either the night-shift or the day-shift phases. However, data from one of the groups also showed a more complex pattern of significant findings. Two points of interest emerged from this analysis. First, the mean reaction times during the Tuesday and Wednesday day shifts were higher than those for any of the night shifts; however, in this case, the more severe effects occurred on the Wednesday rather than the Tuesday.

This finding contrasts with the alertness data (which showed lowest levels on the Tuesday), but it accords with the frequently-expressed views of operators that fatigue associated with shift change was a more serious problem on Wednesday than on Tuesday. Furthermore, the different pattern of results for subjective alertness and reaction times is consistent with evidence that different functions adjust to changed sleep/wake patterns at different speeds (Wever, 1979).

Second, the pattern of change of reaction time over each shift was different from that in the night-shift phase. Thus, during the shift-change phase, reaction times were longest following the mid-shift meal break, becoming faster at the end of the shift. The slow reaction times in the early afternoon (which would correspond to times of low body temperature and alertness in individuals adjusted to night work) and faster reactions at the end of the day were consistent with carry-over effects from the partial circadian adjustment occurring during night shifts.

In addition, 'post-meal dip', which refers to the slowing of performance following a moderate or large meal, and is a familiar feature of cognitive performance patterns (e.g. Smith & Miles, 1987) may have influenced the mid-shift assessments. During the first few day shifts, the point of maximum fatigue would coincide with the 'post-meal' dip, thus possibly accentuating both effects.

The effects of the shift-change were also apparent in responses to the logical reasoning task. Relative to the generally stable trend for the easier items in this test, responses to more difficult items showed a marked discontinuity in the trend of improvement due to practice. Thus, on Tuesday, response times increased over the course of the day rather than showing the expected downward trend. Hence, one
effect of the circadian disruption associated with the shift-change phase was a reversal of the performance improvement achieved through practice during the previous days.

5.3 DAY-SHIFT PHASE

The day shifts tested in the present study were the last four shifts of the offshore work cycle. Patterns of alertness and performance during this phase were relatively stable as compared with the earlier two phases, although during the final day shift (Monday) some disruption occurred possibly associated with pre-occupations about the imminent leave period.

5.3.1 Alertness, sleep, and workload

As compared with the other phases, levels of alertness over the day-shift phase showed less change both across both shifts and across times within shifts. The first day of this phase was the fourth day of day-shift work, and in terms of alertness, it appeared that circadian adjustment had largely been restored to day-shift patterns by then; thus, there was little difference in mean alertness levels over the four shifts, although the final shift showed the lowest overall level. However, the pattern of decreasing alertness from start to end of each shift persisted. This finding is consistent with data reported by Rosa et al. (1985), who found that drowsiness and fatigue increased consistently across 12-hour day shifts (whereas this was not true of 8-hour shifts).

Reported sleep hours during the day-shift phase were relatively constant, maintaining the duration of approximately 6 hours per night established on the first night following the shift-change. However, sleep quality showed a pattern of linear increase across the day-shift week up to the final night of the offshore work cycle when operators reported lower sleep quality than on the previous two nights, a pattern consistent with the lower alertness reported on the final day shift.

5.3.2 Cognitive performance

Reaction times during the Saturday and Sunday of the day-shift phase showed a marked improvement, both in average levels and in stability over the course of the day, relative to the shift-change phase. The morning assessment of the Monday shift showed further improvement; however, a marked reversal of this effect occurred at the final two assessment, unusually slow reaction times being recorded on both occasions, particularly following the meal break. It is not clear what caused this slowing of responses (which was also apparent for logical reasoning items). One possibility is that during the final 24 hours before their scheduled departure from the platform, operators were pre-occupied with their imminent leave and/or affected by cumulative fatigue. Performance deterioration during this final day, which coincided with a decrease in alertness relative to previous days, suggests that operators may be more vulnerable to accidents at this stage of the work cycle. Thus, the finding is consistent with the view that accidents are more likely to occur either at the start or the end of an offshore work period than during the intervening period (Sutherland & Cooper, 1986).
5.4 GENERAL POINTS

5.4.1 Positive mood

Although alertness levels changed significantly over the three work phases, there was no evidence to suggest that the second dimension of mood (positive versus negative affect) showed a cyclic pattern over the offshore work period. Thus, the present data did not substantiate the view that distress fluctuates in a predictable pattern over the two-week offshore period. The main finding relating to distress was a significant reduction in positive mood from start to end of each shift. However, this effect appeared to be secondary to the more marked reduction in alertness which occurred over shifts.

5.4.2 Sensitivity of different cognitive tasks

The overall picture of results obtained from the cognitive performance measures suggested that tasks which were either monotonous and lacking in intrinsic motivation (e.g. the reaction time task) or relatively complex and demanding (e.g. the more difficult logical reasoning items) were particularly sensitive to the effects of fatigue and circadian disruption. In contrast, performance at tasks which presented some degree of variety and interest, whilst still being essentially simple (e.g. active/positive logical reasoning items) seemed less vulnerable to the conditions tested in the present study. These results suggest that the various tasks actually carried out in the control-room may be impaired to different degrees by fatigue effects.

5.5 IMPLICATIONS FOR OFFSHORE SHIFT SCHEDULES

The literature on circadian systems and shift patterns suggests that the present offshore shift schedule is not conducive to the maintenance of optimum alertness throughout the two-week work cycle. The present results are consistent with this view and, in particular, highlight the problems of fatigue and impaired cognitive performance during the shift-change phase. The extent to which the impairments observed in the present study are reflected in the performance of control-room tasks cannot be directly estimated; situational, environmental, and personal factors, and the extent to which the operator invests effort in overcoming fatigue and impaired concentration, are important determinants of actual work performance under any particular conditions. However, a current theoretical model of performance under sub-optimal conditions (de Vries-Griever & Meijman, 1987) throws some light on possible outcomes.

The model describes two possible strategies, with different implications for outcome, which may be adopted by an individual working in a sub-optimal (i.e. fatigued) state arising from long work hours or circadian disruption. Thus, one strategy is continuously to mobilise psychophysiological resources in an attempt to maintain task performance; in this case, well-being is likely to be impaired but performance levels show little or no decrement. Conversely, if the second strategy is adopted, insufficient effort is expended to meet task demands and impaired performance results, although well-being is not adversely affected.

This approach to understanding performance under sub-optimal conditions provides a possible link with the findings of Part I of this report. In view of the nature of their
work, it is probable that offshore operators tend to adopt a strategy of striving to maintain performance (particularly during periods of high activity in the control room) in spite of circadian disruption and prolonged work hours. Thus, impaired well-being would be predicted; this process could contribute to the high levels of anxiety which were reported by offshore operators as compared with those working onshore. The fact that dissatisfaction with shift schedules played a role in relation to anxiety is consistent with this interpretation. It is also possible that individual differences in personality and motivation influence the extent to which operators strive to maintain performance or well-being when fatigued. Therefore, the finding that Type A behaviour was also implicated in the processes leading to high anxiety among offshore personnel is not incompatible with a model of fatigue effects based on a trade-off between performance and well-being.

Taken together, the findings of both parts of the present study suggest that some attempt to improve the scheduling of shift work offshore would be beneficial. The difficulty of modifying offshore shift patterns lies primarily in the nature of the offshore work setting; thus, environmental and organisational factors restrict the use of more favourable shift schedules. However, even within the constraints imposed by offshore work, some possibilities exist for reducing the impact of the abrupt 12-hour change in sleep/wake patterns which the present system imposes twice during the two-week cycle.

From a circadian system viewpoint, a shift pattern in which operators worked the same shift throughout the two-week offshore period (alternating day and night work on successive trips) would be more favourable than the present pattern. This arrangement would eliminate the need to adjust first to night work and then to day work in the same trip, and would also avoid the extended work hours associated with the shift-change. Thus, two major sources of impairment in alertness would be removed. However, such an arrangement might not be acceptable for social and organisational reasons.

Less radical solutions to offshore shift schedules might involve different ways of sequencing work periods over the shift-change days, so as to reduce the necessity for abrupt adjustment to 12-hour changes in sleep/wake routines. The present study does not allow detailed recommendations about alternative shift arrangements to be made, but it does serve to illustrate the problems of the current shift system, and potentially provides a basis for subsequent comparisons with other schedules.

6. FURTHER WORK

The original intention of the present work was to examine shift patterns and their impact on alertness in both onshore and offshore installations. However, offshore shift schedules are largely determined by factors that do not apply onshore; consequently, direct comparisons between onshore and offshore schedules may not be very useful from the point of view of identifying ways of modifying offshore schedules. Furthermore, the survey data (see Part I of this report) showed that only one of the five onshore groups reported levels of dissatisfaction with shift schedules comparable to the offshore values. At other locations, onshore operators were generally very satisfied with shift patterns.

Whilst satisfaction with schedules does not necessarily imply favourable alertness levels, the shift schedules worked by the onshore operators tend to be variations on
the general pattern of 'fast rotating' shifts advocated on the basis of comparative studies of different systems. Thus, in general, onshore shift schedules do not appear to present major problems as compared with those used offshore. Consequently, greater benefit is likely to be gained from examining possible alternatives to the present offshore schedules, although comparing patterns of alertness and mood change across the onshore and offshore environments would also be of potential value.

Several possible approaches to extending and further developing the study of alertness and performance described here can be outlined:

- The present sample was smaller than originally intended, some further data collection (possibly using a more limited range of cognitive tasks) to increase sample size would be desirable. In particular, a larger sample would allow some examination of individual difference effects.

- To evaluate the extent to which change to the existing shift patterns would be beneficial, it would be necessary to examine fluctuations in alertness and performance under alternative systems, either introduced specifically for experimental purposes or already in use at other installations.

- In addition to the formal test sessions (which require the presence of an experimenter offshore), a diary system of recording sleep duration and quality, workload, and subjective fatigue, would allow additional data to be collected in future work. This approach would complement the objective assessments in allowing information to be obtained from a larger sample, while reducing the demands made on the operators' time, and on offshore resources (e.g. accommodation).

- Diurnal changes in body temperature reflect the physiological adjustment of the circadian system; thus, assessment of oral temperature at the time of alertness testing would add to the self-report and performance data in establishing the effects of different shift systems. Alternatively, offshore medics might be able to assist with routine temperature monitoring during shift sequences.

- In relation to onshore locations, it would be of interest to examine the shift patterns in operation at the installation which reported relatively low satisfaction levels, and to determine whether any changes would be feasible and potentially beneficial.

- The cognitive tasks used in the present work were relatively simple compared with the control-room tasks undertaken by operators. An alternative research approach, which might play a useful role in future work, would be to develop simulated control-tasks (using computer-generated displays), and to use these more realistic tasks to study factors affecting performance both under controlled laboratory conditions and in field studies.
ACKNOWLEDGEMENTS

The author gratefully acknowledges the following organisation and individuals, without whose co-operation and assistance this study could not have been carried out;

- Major funding for the work was provided by the Health and Safety Executive, under contract 1/LMD/126/374/89 with the University of Oxford; additional funding was contributed by BP Exploration, Aberdeen, and by the University of Oxford.

- The research was carried out with the co-operation and encouragement of Dr Ian Macaulay of the BP Exploration Medical Department and his staff, particularly Dr Gordon McRuvie. Data collection was facilitated by management personnel at the onshore and offshore installations concerned, and by the interest and commitment of those who participated in the study.

- Several research assistants contributed to the various stages of the work. In Aberdeen, Ms Wendy Metcalfe, Dr Sam Brooke, and Ms Alyson Jack assisted with data collection; in Oxford, Mrs Davina Rendall, Dr Maria Yapp, Ms Ros Savournin, and Ms Clare Mendham assisted with data processing and statistical analysis. Most recently, secretarial assistance in preparing the camera-ready text of this report was provided by Ms Kay Lattimore, while Ms Alison Fry was responsible for the presentation of the tables and figures.

- The Institute of Aviation Medicine, Farnborough provided cognitive tests used in Part II of this study; Cpl Jon Coldwell of the Psychology Division made the necessary modifications to the computer programs.

- Publication of the research in its present form was facilitated by Dr Elizabeth Gibby of the HSE Health Policy Division, and Mr Robert Miles of the HSE Offshore Safety Division.

To each and all of those concerned, the author would like to express her sincere thanks and appreciation.
REFERENCES


