ANALYSING STRESS IN OFFSHORE SURVIVAL COURSE TRAINEES

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Background information and data arising from these research projects are published in the OTI series of reports.
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GLOSSARY OF TERMS AND ABBREVIATIONS

Analysis of variance (ANOVA)  A way of investigating differences between the means of a specific factor measured in different subject groups.

General linear model (GLM)  An approach to ANOVA that requires neither complete data sets, nor a balanced design.

HR  Heart rate

HUET  Helicopter underwater escape training

Multivariate ANOVA (MANOVA)  An extension of ANOVA in that the means of several different factors may be assessed.

OPITO  Offshore Petroleum Industry Training Organisation

P-values  Probability values calculated during statistical tests. For example, if p=0.04, the event would be said to be significant at the 5% level, because the p-value was less than 0.05.

Repeated measures MANOVA conducted on a particular factor that has been measured more than once, eg anxiety scores taken on days one to five.

SC  Salivary free cortisol

Significance level  Gives an indication of the reliability of the inference made from a statistical test. For example, if a significance level of 5% was chosen, an inference made following a test would have a probability of 5%, or 1 in 20, of being incorrect.

STAI  State trait anxiety inventory
(Student's) T-test  A statistical test used to compare sample means. In this study, predominantly two sample paired t-tests were conducted. Paired tests were used on two samples that were not independent, for example, before and after recordings from one subject. As the difference between each paired recording was assessed, the subject variability was removed.

TEMPSC  Totally enclosed motor propelled survival craft

Tukey's WSD test  Usually conducted after ANOVA to determine whether significant differences exist between the specific factor means of two or more particular groups.

UFC  Urinary free cortisol (taken as a ratio against creatinine)

UKOOA  United Kingdom Offshore Operators Association
SUMMARY

This report (OTH 94 446) describes a three year study of trainee responses to offshore survival training at one training centre, RGIT Limited. The main aims of the study were to assess the psychological and physiological stress experienced by trainees, and to identify whether the sources of stress were related to the training or due to factors outwith the training environment. The influence of age and experience of training were also investigated.

Measurements, chosen as acknowledged indicators of stress, were made on individuals undergoing offshore survival training. Attention was centred on four exercises representing the four parts of training. The four exercises that were considered to be potentially psychologically and physically demanding were the: helicopter underwater escape training (HUET); simulated platform abandonment drills by way of totally enclosed motor propelled survival craft (TEMPSC); simulated platform abandonment drills into life rafts; and self rescue from a smoke filled room, using breathing apparatus (BA).

The findings of the study indicated that most trainees were especially anxious at the start of the course. Suggestions are made that could be used to reduce what appeared to be pre-course apprehensions. Prior to the start of the training course the HUET was perceived to be the most difficult exercise. The heart rate responses of trainees to the HUET during the course were, however, lower than to some of the other training elements. Overall, the four training events were not found to result in levels of physiological or psychological stress more than might be expected while working offshore. Particular problems were, however, found to be associated with the fire training and HUET exercises. These were smoke contact and disorientation, respectively. Possible means of alleviating these issues are discussed.

Age was found to be important in the refresher group. Older refreshers were found to be less anxious. This was most probably a result of experience, suggesting that repeating training reduces the anxiety felt by trainees. Reducing feelings of anxiety regarding survival training was seen as especially important following the finding that lower anxiety was associated with greater perceptions of coping. In other words, those who were more relaxed, gained more in terms of building confidence during the training.

Possible future areas of research are also discussed.
1.0 INTRODUCTION

To work offshore, individuals are generally required to have offshore survival certificates. These are obtained by undergoing training at establishments which provide OPITO (Offshore Petroleum Industry Training Organisation) registered courses. There are, however, arguments that the demands of training are too high, especially for "the ageing offshore population". Yet, although the view that the offshore population is ageing is frequently expressed, it is rarely supported by data. This study, therefore, was initiated to investigate the anecdotal suggestion that survival training may cause undue stress to the ageing workforce. The study was largely backed by RGIT Limited, with additional co-operation and funding from the Offshore Safety Division of the Health & Safety Executive and British Gas. The results of the investigation are detailed in this report (OTH 94 446) entitled "Analysing stress in offshore survival course trainees".

When survival training has been applied in an actual emergency situation it has, for example, been quoted as being of "decisive moment in the escape and survival" of helicopter crash victims (Hyttten, 1989). Further, the advantages of training in case of helicopter ditching and capsizing have been demonstrated in a study by Bohemier, Chandler & Gill (1990). They found that the rate for naive subjects successfully egressing from the inverted METS (Modular Egress Training Simulator) increased at least 3 fold, following 7 repeated capsized trials. Seven repetitions, it should be noted, are considerably more than the 2 capsizes which present trainees, new to offshore survival training, have the opportunity to learn from, and this only at certain training establishments. Evidence of 'real life' benefits of training are also illustrated in a study by the Naval Safety Center (Ryack et al, 1986) of helicopter crashes between 1969 and 1975. Of the 400 or more people involved, fewer than 8% of those who had received training in underwater escape died in such crashes, compared to more than 20% who received no such training.

The standards outlining what training should provide are set out by OPITO and are based on training guidelines that are published by the United Kingdom Offshore Operators Association (UKOOA) (Batchelor, 1993). Various criteria are used for setting the training level, including consideration of trainees' previous experience and capabilities. Refresher training is provided for individuals with 'experience' of survival training within the previous 4 years. 'Capability' can be addressed by medically screening all trainees.

Trainers themselves can play a vital role in maintaining the effectiveness of survival courses. Indeed, according to UKOOA guidelines (1991)
ongoing assessment should take place including monitoring of the effectiveness of training and how well the content is retained by trainees. RGIT Limited has reacted to this responsibility in several ways. Firstly, having completed any course, individuals are asked to comment by completing forms; evaluating everything from the course content to the standard of instruction, and finally being quizzed on their own knowledge of the course. The results of these forms are analysed monthly, and, where necessary, acted upon.

This Offshore Technology Report, however, gives the results of a 3 year investigation conducted by RGIT’s Research Unit into how trainees react to survival training. The aims of the study were:

1. To quantify the degree of psychological and physiological stress experienced by trainees, during survival training.

   By its very nature survival training can be demanding. Indeed certain levels of stress may be necessary to induce beneficial changes. At the other extreme, however, too much stress could result in the individual’s competence being reduced. The study aimed to explore the levels of stress that trainees actually experience.

2. To determine the effectiveness of training.

   The study examined whether training enhanced the individual’s basic capabilities, and if their prejudices about training and about their ability to cope were matched by the reality. In addition, it sought to identify problem areas, and distinguish their origins, i.e. were they a result of training methods, or due to some other factor or factors outwith the training environment.

3. To assess the impact of training on an ageing population.

   Subjects across the age range 20 - 59 years were observed, in order to enable comparisons to be made among the different age groups.

This research was embarked upon so that accurate information would be available for consideration when the requirements of offshore training are decided. Without such essential information on effectiveness, appropriateness, and response of the trainee, useful change is not possible.
2.0 RESEARCH METHOD

Physiological and psychological measurements, chosen as indicators of stress, were made on individuals undergoing offshore survival training. Details of the overall content of the refresher and combined basic courses are contained in Appendix 1. Attention was centred on four exercises to represent the four parts of training, namely:

- helicopter underwater escape training (HUET);
- simulated platform abandonment drills by way of totally enclosed motor propelled survival craft (TEMPSC);
- simulated platform abandonment drills into life rafts;
- self rescue from a smoke filled room, using breathing apparatus (BA).

These four exercises were considered to be potentially psychologically and physically demanding.

2.1 METHODOLOGY

2.1.1 Course specific questionnaires

All subjects were requested to complete all sections of a series of course specific questionnaires. The questionnaires are contained in Appendix 2, and include:

- 'Subject details-1' - this form was included in case subjects had to be contacted outwith the training course. Before the subject completed the form the investigator added the subject's personal code to emphasise that confidentiality would be maintained;

- 'Subject details-2' - this questionnaire was developed to determine the individual's previous experience of survival training and the offshore environment;

- 'Subject details-3 PSE' - this examined the subject's impression of the training before they commenced the course, or their perceived self-efficacy (PSE);

- 'Post activity evaluations' - these were designed to assess the subject's evaluation of each part of the training being investigated, immediately after the event;

- 'Perceived outcome' - this determined the subject's evaluation on completion of the course.

Completion of these forms therefore provided an indication of the individual's perception of their own ability to cope before, during and after the training.
2.1.2 Psychological questionnaires

Psychological stress was assessed using Spielberger's State Trait Anxiety Inventory (STAI). This is a two part questionnaire designed by Spielberger in collaboration with Gorsuch, Lushene, Vagg, & Jacobs (1983). Each part has 20 questions with the respondent marking 1 of 4 possible standard options to each question - always, sometimes, rarely, never. Scoring was carried out using a standard key, with possible scores ranging between 20 and 80. The state form, Y1, was designed to measure situational anxiety. The directions, therefore, request the respondent to indicate how they feel "right now, that is, at this moment". The trait form, Y2, measures the individual's inherent anxiety. The directions for this form request the respondent to consider how they "generally feel".

The Sensation Seeking Scale or Interest and Preference Test, a questionnaire designed by Zuckerman (1979), was used to assess personality. There are 40 questions, each with 2 possible responses. Responses were recorded on a separate answer sheet. A template was made to fit over the answer sheet, and this was used to enable easy and accurate scoring. The questions asked split into 4 different groupings; Experience Seeking (ES), Thrill and Adventure Seeking (TAS), Disinhibition (Dis), and Boredom Susceptibility (BS). Possible scores range from 0 to 40 for total scores, and 0 to 10 for each of the subcategories.

A further appraisal of personality was conducted using the Locus of Control scale, designed by Rotter (1966). An individual's locus of control can range from being; external, that is the belief that life is under the command of forces outwith one's control, to internal, in which case the individual believes that he/she has direct control over the outcome of his/her own life. As the measure is a scale, individuals generally fall between the two extremes. The Locus of Control scale consists of 29 questions, each with 2 possible responses. Responses were recorded on a separate answer sheet. A template was used in scoring this questionnaire. Six of the questions are "fillers". The responses to these were therefore not used in the overall score. Total scores thus range from 0 to 23. There are no subsections to this questionnaire, the overall score being considered as a point along the scale.

2.1.3 Heart rate measurement

A Polar Sports Tester model PE 4000 was used to monitor and continually record heart rate. This portable microprocessor incorporates a battery powered electrocardiogram (ECG) sensor and transmitter. The processor connects to a chest strap that includes two contact electrodes. The chest strap was worn directly in contact with the subject's skin, the sensor being positioned approximately over the sternum. A small amount of moisture applied to the contact electrodes facilitated the initial detection of the heart signal. Signals from the transmitter are then picked up by a receiver,
which takes the form of a watch worn on the subject's wrist. Heart rates are stored within the microprocessor in the watch. Three storage options are available: 5, 15, or 60 second time periods, with a total storage time of 2 hours and 40 minutes, 8 hours, and 33 hours, respectively. The data can then be recalled manually using the function buttons on the watch, or be downloaded for storage on disk, using an interface and Polar software. The software also enables averages to be determined later over any specified periods. Heart rate traces stored on disk were labelled using a coding system similar to that used for the salivary and urinary cortisol samples. The Sports Tester has recently been compared with direct ECG measurement, and found to be both accurate and reliable (Seaward et al., 1990).

2.1.4 Exercise test
An incremental exercise ergometer test, which would elicit heart rates of no more than 75% of an estimated maximum, was developed for the study (see Appendix 3). Work loads used ranged from 50 watts to a maximum of 150 watts, over increments of 25 watts. The test, which incorporated allowances for age and fitness, was applied, and found to be effective in eliciting a range of heart rates. To obtain a quantifiable indication of aerobic fitness, linear regression was conducted on the heart rates attained during the exercise test. A heart rate value was thereby estimated for each subject working at 75 watts. This value could be used both as an estimate of aerobic fitness, and for comparison with the heart rates reached during the training course.

Lung function was assessed using a Vitalograph spirometer with built in printer.

Harpender callipers were used in the measurement of body fat. Three readings of skinfold thickness were taken at each of the following sites: biceps, triceps, subscapular, and suprailiac. An average for each site was calculated, the 4 resulting averages were summed. Then, using Durmin and Womersley's tables (1973) this final figure was used to determine total percentage body fat. Height and weight were measured, with individuals in normal clothing but not wearing shoes.

2.1.5 Collection of cortisol samples
Assessment of cortisol was included as it is generally accepted as a valid indicator of "altered physiological states in response to stressful stimulation" and "of psychologically-induced stress" (Kirschbaum & Hellhammer, 1989, Ben-Aryeh et al, 1985). Cortisol in saliva is an acute measure, reflecting the activation of the hypothalamic-pituitary-adrenal axis (HPA) over the last 20 to 90 minutes, depending on the stimulus. Salivary cortisol was therefore used as a short term indicator of changes in the HPA axis. There is a delay before cortisol enters the urine, however,
hence urinary cortisol represents a chronic measure, and was used as an indicator of any long term changes in the HPA axis.

Saliva and urine samples were collected at various times throughout the course (see 2.2.2).

Both urine and saliva samples were analysed for concentration of cortisol using "Coat-a-Count", a commercially available radio immunoassay technique, produced by Diagnostic Products Corporation. Samples that were stained and/or viscos were rejected. Absolute values were used for salivary free cortisol, that is the level of unbound cortisol in saliva. Urinary cortisol, however, was measured as a ratio against creatinine, thus controlling for varying dilutions of urine. Samples were analysed by the Department of Clinical Biochemistry at Aberdeen University Medical School.

2.1.6 Data handling
The data was set-up in DataEase, a relational database produced by Sapphire International plc. Each dataset (a total of 139 datasets were created) was assigned a relevant code, as well as a number (see Appendix 4). The codes were used predominantly for reference in the database, whereas, the numbers corresponded to questions on forms and questionnaires. As each subject's forms accumulated, it was found to be useful to record all of an individual's data on a summary sheet. These summaries could thus be referred to directly, whilst the bulk of the forms were stored separately.

2.2 PROTOCOL

2.2.1 Recruitment
Subjects were selected from classes of trainees at enrolment. Selection was carried out such that the study population was representative of the age range 20 to 60 years old. Initially it was intended that 15 subjects be recruited from four age categories, the twenties, thirties, forties and fifties, for refresher and combined groups. This would give a total of 120 subjects. Only individuals with clear health screening forms were selected. No other selection criteria were used. Individuals were taken apart from the main group and, to satisfy ethical considerations, given a verbal outline explanation of the study. (This study was cleared by the Joint Ethical Committee of the Grampian Health Board and the University of Aberdeen in August 1991.) Individuals were told that the study was investigating the responses of individuals to survival training, and were requested to consider volunteering to take part. They were then given a volunteer information sheet, which reiterated in writing what they had just been told (Appendix 5). Emphasis was placed on the recruitment being
voluntary. If the individual then agreed to become a subject, they were asked to complete a consent form.

Subjects then completed a series of questionnaires concerning their experience both offshore and regarding survival training. A further questionnaire was administered to assess the subject's own perception of their ability to cope with the survival training.

The last questionnaires completed at enrolment were Spielberger's state and trait anxiety inventories, in that order. An initial explanation was given prior to completion of these forms. Once the state form had been completed, the distinction between the state and trait requirements was emphasised, and the subject then completed the trait form.

Finally volunteers were requested to provide saliva and urine samples. Two 20ml tubes were supplied to the subject, who was requested to urinate into one and then, soon afterwards, expectorate into the other.

2.2.2 Data collection during the course
Saliva samples were collected before and after the: HUET drills; abandonments to life raft and to TEMPPSC; self-rescue exercises from a smoke filled room; and exercise tests. No pre-abandonment to life raft samples were procured from refresher subjects, as, during the refresher course, the abandonment was carried out immediately after the HUET. A sample taken before the abandonment would, therefore, reflect the post effects of the HUET, rather than the pre effects of the abandonment. Urine samples were obtained from the subjects early on each morning of the course.

Similarly state anxiety scores were recorded, using Spielberger's inventory, immediately prior to the: self-rescue with BA fire training exercise; HUET; abandonment to a life raft; and abandonment using a TEMPPSC; and early on each morning of the course.

Before any of the 4 selected activities, subjects were fitted with a Polar Sports Tester model PE 4000. The recording intervals were set at 5 seconds for all of the exercises, except for the duration of the trip to sea during the TEMPPSC training, and during the refreshers' HUET and abandonment to life raft exercises, which were combined within 1 pool session. During the trip to sea, the recording time was set for every 60 seconds. No detailed analysis was to be carried out on the sea trip, hence the longer time interval. During the refreshers' HUET and abandonment drills, the time interval was set at 15 seconds. This was necessary as, including briefing time, the consecutive exercises took 3 hours, which is outside the maximum storage time for 5 second recording.
The relevant times were noted from a Sport tester watch worn by the investigator. All Sport tester watches were synchronised weekly.

Following completion of each section of the course, subjects were requested to complete the relevant post-activity evaluation form. At this time they were also supplied with a sample bottle, anxiety inventory, and directions for use early on the following morning.

2.2.3 Exercise test
Prior to starting the exercise test each subject was fitted with a Sports Tester. A 5 minute recording was then made while the subject was seated at rest. Aerobic fitness was assessed using a Monarch ergometer, according to the protocol in Appendix 3. Saliva samples were obtained before and after the exercise.

Height, weight, and body fat were measured, as well as lung function.

The personality questionnaires described in section 2.1.2 were completed at this time. Emphasis was placed on explaining these forms.

2.2.4 Completion of course
On completion of the training course, subjects were requested to answer the questions posed in the "perceived outcome" form (Appendix 2). Subjects were also given a print-out of their heart rate trace from the exercise test. An indication of their aerobic fitness was included with this, along with their percentage body fat, and normal values of these variables from individuals in their age group.

2.3 INITIAL TRIAL
An initial trial was performed on two trainees, to test the proposed methodology, and identify problem areas.

Recruitment had been foreseen as one possible problem area. For example, there was some doubt that subjects would agree voluntarily to take part, with no incentive other than some feedback regarding personal fitness. This trial run showed, however, that generally individuals were amenable to taking part.

Recruitment of subjects at the enrolment stage of the course was confirmed as being the most suitable time. It was established that the time required for each subject to complete the initial forms, and provide urine and saliva samples, was a minimum of 20 minutes. Given that the time available was a maximum of 40 minutes, and ideally 4 subjects should be recruited per week, additional help was required. This was provided by staff of the RGIT Limited Research Unit.
When asked, individuals had not experienced any discomfort whilst wearing the heart rate monitors. Training officers were requested to ensure that study subjects were treated as any other trainee.

Course specific questionnaires did not generate any difficulties during the initial trials.

The Sports Tester microprocessors (see s2.1.3) were found to be effective in continually detecting and recording heart rates. Interference in the form of improbable heart rates, e.g. drops to zero, was observed to occur when subjects were close together. Subsequently individuals were allotted to different groups within the class during practical exercises, and otherwise requested to maintain at least a 1 metre distance from other volunteers.

It was confirmed that printed sheets for recording timings during the 4 selected exercises (HUET, abandonment to TEMPSC and life raft, and fire fighting training) would be necessary. Times were then recorded on individual activity diaries in order to maintain consistency. To ensure that all times noted were accurate, weekly synchronisation of the watches used was commenced. Any difference among the 5 watches was noted.

Little problem was found with the timing, nor with the method of collection of saliva and urine samples.

2.4 THE PILOT STUDY

As no major problems were encountered, a pilot study was therefore begun. Data collection proceeded according to the plan of work (see s2.2). Two groups of 15 subjects were measured. Individuals were selected from across the originally specified age range. Only 4 individuals declined to take part in the study, during this pilot phase.

2.4.1 Summary of findings from the pilot study

The pilot study demonstrated that:

- individuals were willing to volunteer and continue to act as subjects throughout the duration of their training course;
- it was possible to collect the full complement of originally outlined data;
- heart rates could be measured continually: the most pertinent sections for analysis were also established;
- data collection should continue to the original proviso of 120 subjects.
3.1 DATA COLLECTED

Ninety-nine subjects were observed while undertaking either the 3 day Offshore Basic Survival and Fire fighting Refresher course, referred to as "refresher", or the 5 day Combined Offshore Survival and Fire fighting Course, referred to as "combined". (Note that not all combined subjects were entirely naive to the training, see 3.2.1.) Overall, 52 refreshers and 47 combined subjects were observed, according to Table 1:

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Subject numbers, by age</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Age ranges (years)</td>
</tr>
<tr>
<td>Refresher</td>
<td>15</td>
</tr>
<tr>
<td>Combined</td>
<td>15</td>
</tr>
<tr>
<td>Totals</td>
<td>30</td>
</tr>
</tbody>
</table>

Age groupings were defined, putting individuals in their twenties, thirties, forties, and fifties together, as per Table 1. Five of the defined age groups contained the originally specified number of subjects, while both of the 50’s groups and the combined 40’s group fell short of the intended quota of 15. Despite the representative nature of the sampling, it was found that there was simply a lower proportion of older individuals, taking part in survival training. This impediment to observing 120 subjects, from across a full age range, and the urgent requests for information from the project’s main sponsor (RGIT Limited), meant that analysis proceeded with slightly less than the originally intended number of subjects.

3.2 DEMOGRAPHIC/BACKGROUND DATA

The total population were split according to whether individuals were observed during a 3 day refresher course, or a 5 day combined course. Further subdivisions were based on age groupings. The average age of all the refresher subjects was \(37 \pm 10\) years, and \(35 \pm 10\) years for all combined subjects, with ranges of 21 to 56 years, and 19 to 53 years, respectively.

3.2.1 Offshore & survival training experience

From the refresher group, 92% \((n = 48)\) were in employment, 98% \((n = 51)\) having worked offshore. Within the combineds, 94% \((n = 44)\) were
employed, 45% (n = 21) with offshore work experience. The majority of
individuals, both refreshers and combined, were completing the training
because of job requirements.

Given that all refreshers had previously taken part in survival training,
92% (n = 48) had experience of HUET, 94% (n = 49) of abandonment
into a life raft, 96% (n = 50) of fire fighting training, and 98% (n = 51)
of abandonment into a life craft. Of the combined subjects, only 28% (n
= 13) had undergone survival training, 17% (n = 8) had experience of
HUET, and 23% (n = 11) of abandonment into a life raft; however, 36% (n
= 17) had experience of fire fighting training, and 30% (n = 14) of
abandonment into a TEMPSC. There appears to have been a discrepancy
among combined subjects regarding the extent of offshore experience
versus survival training experience. This was probably a result of the
former varying requirements by Operators for survival training prior to
working offshore. Subjects were requested to provide details of previous
attendance of survival training courses. The extent of information provided
was, however, variable hence the data were not considered to be
sufficiently reliable to use in the overall group analyses. Future studies
would benefit from pursuing this factor.

3.2.2 Course expectations
Individuals' perceptions of which aspects of the courses they would find
most and least able to handle are given in Figures 1a & 1b and 2a & 2b.

Life craft, TEMPSC, abandonment was regarded as being most easily
handled (see Figures 1a & 1b). This was reiterated in that life boats were
also scored the lowest on the exercise that was expected to be handled
least effectively (see Figures 2a & 2b). HUET and fire fighting stood out
as the exercises that were perceived to be most difficult, HUET more
obviously in the combined group, fire fighting slightly more in the
refresher group. The former distinction may have been a result of the wide
spread exaggerations regarding the HUET, with the majority of combined
subjects having no previous experience to contradict these tales. (Having
undergone HUET training the temptation appears to be to describe it in the
worst possible light to those who have not completed the training.)
Similarly, few individuals new to training would have come across the
realities of large-scale fires that were contained within a building, and
therefore would not have reason to perceive the fire training as especially
difficult. The refresher subjects, on the other hand, would have
experienced fire fighting, possibly from before the more recent changes in
the practical activities. (Within the 2 years before this study, fire training
was modified by reducing the heat within the smokehouses, and supplying
trainees with more extensive protective clothing.) Refresher subjects
would thus have been aware of the difficulties that could be incurred, for
example, the discomfort of smoke in the nose, eyes and throat, or the
extreme heat emitted from large gas flames.
Figure 1a
"Which exercise do you think you will handle most effectively?" - refresher subjects

Figure 1b
"Which exercise do you think you will handle most effectively?" - combined subjects

Figure 2a
"Which exercise do you think you will handle least effectively?" - refresher subjects
3.2.3 Physical abilities

When asked to rate physical fitness, 67% (n = 35) and 49% (n = 23) perceived themselves as adequately fit, whereas 23% (n = 12) and 34% (n = 16) perceived themselves as quite fit. From those sampled, 6% (n = 3) and 13% (n = 6) rated themselves as non-swimmers. Results are for refreshers and combined, respectively. (See Table 2 for overall ratings.)

<table>
<thead>
<tr>
<th>Physical fitness rating:</th>
<th>Refresher subjects</th>
<th>Combined subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very fit</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Quite fit</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td>Adequate</td>
<td>35</td>
<td>23</td>
</tr>
<tr>
<td>Unfit</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Totals</td>
<td><strong>52</strong></td>
<td><strong>47</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Swimming ability rating:</th>
<th>Refresher subjects</th>
<th>Combined subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very good</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Quite good</td>
<td>10</td>
<td>18</td>
</tr>
<tr>
<td>Adequate</td>
<td>32</td>
<td>19</td>
</tr>
<tr>
<td>Non-swimmer</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Totals</td>
<td><strong>52</strong></td>
<td><strong>47</strong></td>
</tr>
</tbody>
</table>
3.3 ANALYSIS OF COURSE SPECIFIC QUESTIONNAIRES; CORRELATION WITH DEMOGRAPHIC DATA

Analyses on the course evaluation and outcome questionnaires were carried out on the data from the completed groups, initially based around the HUET exercises. Means and standard deviations were calculated, and later plotted as histograms. This served to provide a method of detecting any obvious patterns, changes, groupings, etc. Subsequent analysis was expanded to include all 4 of the selected exercises, these being HUET, abandonment into a life raft and into a life craft, and fire training using BA.

The general linear model (GLM) approach to analysis of variance (ANOVA) was applied to the ranked evaluation questionnaires, to determine if there were any age, fitness rating, swimming ability rating or smoking dependent differences. One-way ANOVA was applied to the responses to the remaining, categorical course evaluation and outcome questionnaires. Tukey's pairwise comparison was consequently applied to the categorical data to distinguish where differences lay. (The Tukey's test was always conducted at the 5% significance level.)

Comments have been noted for those within question differences that were found to be statistically significant, or when a lack of statistical difference was interesting in itself. The following symbols have been used to represent p-values of less than: 0.10 †, 0.05 *, 0.01 **, or 0.001 ‡. These values are ordered according to increasing levels of significance.

3.3.1 Fire fighting training evaluation

Smoke was the major source of difficulty for combined subjects (see Figure 3b). Refreshers found disorientation, as well as smoke, to be the more difficult aspect of the fire training to cope with (see Figure 3a). This may be a result of the more complex smokehouse that was used for refresher training. Similarly, the exercises that involve most 'smoke contact' were given as the most difficult, self-rescue with BA and real smoke without BA, for refresher and combined subjects, respectively (see Figures 4a and 4b). (It should be noted that the refresher course did not include the exercises involving real smoke without BA, nor cosmetic smoke with BA.) The BA donning and walk about was found to be the most difficult by some refreshers. This was possibly a reflection of the physical nature of this exercise.

Combined subjects who rated the real smoke without BA exercise as the most difficult had a significantly ‡ lower sample mean age, 33 years, than those who rated all the other possible responses, 41 years. Using a Tukey's paired comparison this difference was confirmed.

p-value <0.10 †; <0.05 *; < 0.01 **; <0.001 ‡.
On the whole subjects felt they coped either very well or well with the fire training (see Figures 5a and 5b). Rightly five per cent (n = 33) of刷新ers, and 98% (n = 41) of combineds felt they coped well or very well. No significant difference was found in age within the combined or refresher responses.

GLM demonstrated that only the smoking factor had a significant effect ** among the refresher responses to how satisfied individuals were with the way they coped with the fire training. From the effect values, it was found that smokers were less satisfied with the way they had coped than their non-smoking counterparts. No such effect was found among the combined subjects. Age did, however, have a significant effect * among combined responses. A negative age coefficient indicated that the older combined subjects were more satisfied with the way they had coped. Self-rated fitness was close to significance at the 5% level, \( p=0.054 \). The GLM effect values indicated that the fitter individuals were more satisfied.

**Figure 3a**
Aspect of fire training most difficult to cope with - refresher subjects

**Figure 3b**
Aspect of fire training most difficult to cope with - combined subjects
Figure 4a
Most difficult fire training exercise - refresher subjects

Figure 4b
Most difficult fire training exercise - combined subjects
Figure 5a
How well subjects felt they coped with fire training - refresher

Figure 5b
How well subjects felt they coped with fire training - combined
3.3.2 Helicopter Underwater Escape Training (HUET) evaluation

For refresher and combined subjects, disorientation clearly was the most difficult factor of the HUET training (see Figures 6a and 6b). General anxiety also appeared to be prominent, and was rated by the same number of refresher and combined subjects. Remembering instructions was more highly rated by combined subjects, which may have been expected for individuals taking part in a training course for the first time.

From the question 'Which aspect of the helicopter underwater escape did you find most difficult to cope with?', the mean age of those refreshers rating general anxiety, 34 years, was close (p = 0.062) to being significantly lower than the mean age of those who rated any of the other possible responses, 42 years, except disorientation. According to the Tukey’s test, for combined subjects, those rating general anxiety were significantly older, 41 years, than those who found breath holding, seat belt release, or finding an exit, 29 years, as the most difficult aspect. The refresher and combined results thus oppose each other. This may have been a result of the older refreshers having more experience than their younger counterparts. Any increase in general anxiety with age would therefore have been overridden by experience.

The most difficult exercise for refreshers was found to be the fast capsize, the only capsize practised by refreshers. Combined subjects rated the fast and slow capsize equally (see Figures 7a and 7b). No significant age difference was found between the capsize for combined subjects.

As with the fire training, most subjects felt they coped either very well or well with the HUET (see Figures 8a and 8b). In fact, totalled responses show that 86% (n = 44) of refreshers and 93% (n = 43) of combineds felt they had coped well or very well. No significant age, fitness, swimming, or smoking effects were found, among the possible responses for refresher subjects. Although age was found to be significant at the 10% level for combined subjects †. Further, as the coefficient was negative, older individuals were more satisfied with the way they coped. There was also a general trend of fitter individuals feeling more satisfied †.

p-value <0.10 †; <0.05 *; < 0.01 **; <0.001 ‡.
Figure 6a
Aspect of HUET most difficult to cope with - refresher subjects

Figure 6b
Aspect of HUET most difficult to cope with - combined subjects
Figure 7a
Most difficult HUET exercise - refresher subjects

Figure 7b
Most difficult HUET exercise - combined subjects

Figure 8a
How well subjects felt they coped with HUET - refresher
3.3.3 Abandonment training evaluation

The physical aspects of the abandonment drills, especially the life raft motion, were rated as being most difficult to cope with by refresher subjects, though swimming did not figure as largely as might have been expected. Combined trainees, however, rated difficulties across the range of options, again as might be expected given their previous lack of training experience. (See Figures 9a & 9b.) At the 5 % significance level, differences were found in the combined mean group response ages. According to Tukey’s pairwise comparison the mean age of those rating general activity, 41 years, was significantly higher than those rating life raft motion, 28 years, as the most difficult aspect to cope with.

Exercises relating to entering and righting rafts, and scramble nets were the most difficult for refresher subjects as seen in Figure 10a. Conversely, only 1 combined subject rated the life raft righting as the most difficult, most subjects found entering the rafts, and scramble nets to be the most difficult exercises (see Figure 10b). This may have been a reflection of the fact that raft righting was contained within the one session, along with HUET and simulated abandonment, for refresher. The evaluation questionnaires being completed after this single session. The combined subjects, however, took part in a separate wet drill, during which righting of rafts was practised. The abandonment, and evaluation questionnaire, being completed later. Consequently the raft righting may not have been as fresh in the memory of combined subjects when completing the evaluation form. Significant differences were found relative to age for the combined responses to the most difficult exercise question. According to the Tukey’s test, those individuals who rated the scramble net as the most
difficult, had a significantly higher mean age, 39 years, than those who rated entering life rafts, 30 years.

Neither self-rated fitness nor swimming ability was found to have any effects on the abandonment evaluation questions, except for the refresher responses to which exercise was the most difficult. Following one-way ANOVA, average self-rated fitness was found to differ significantly * among the refreshers' responses. Confidence intervals, as estimated by Tukey's paired comparison, show that those who scored the raft righting and those who scored entering the raft are close to being significantly fitter, in their own rating, than those who scored scramble nets.

Again most subjects felt that they had coped either very well or well with the abandonment training. Two per cent (n = 1) of the refreshers felt that they did not cope at all well, and 12% (n = 6) of refreshers and 7% (n = 3) of combined subjects, were only somewhat satisfied with the way that they had coped. For refresher and combined subjects, significant age, swimming, and fitness effects were not found among those who felt they had coped very well, well or somewhat well with the abandonment training. Combined subjects who smoked were found to be less satisfied with the way they had coped *. No combined subjects felt that they had not coped well. *

![Figure 9a](image)

_Figure 9a_
Aspect of abandonment most difficult to cope with - refresher subjects

$p$-value $<0.10 \dagger; <0.05 \ast; <0.01 \ast\ast; <0.001 \ast\ast\ast$. 
Figure 9b
Aspect of abandonment most difficult to cope with - combined subjects

Figure 10a
Most difficult abandonment exercise- refresher subjects

Figure 10b
Most difficult abandonment exercise- combined subjects
3.3.4 TEMPSC abandonment training evaluation

Generally, subjects scored across the range of possible responses for the aspect of the TEMPSC that was most difficult to cope with (see Figures 12a & 12b). The only notable factor was that, out of 97 individuals, only 1 rated general anxiety as difficult. This therefore was a strong indicator of the generally low levels of anxiety associated with TEMPSC training.

Figures 13a & 13b demonstrate that considerably more combined than refresher subjects found the handling at sea the most difficult exercise. This might have been expected given that only 30% (n = 14) of combineds had any previous life boat experience, in contrast to refresher’s, 98% (n = 51) of who had previous experience. Coxswain training appeared to generate some difficulty. It was, however, frequently noted by trainees that this exercise was simply the 'least easy'.

\[ p\text{-value} < 0.10 \ ; \ <0.05^* < 0.01^{**} < 0.001 \ . \]
All combined subjects felt that they had coped either well, 52% (n = 24), or very well, 48% (n = 22) (see Figure 14b). Most refresher subjects responded similarly, only 3 feeling that they had coped somewhat well (see Figure 14a).

No significant age, swimming ability, or fitness effects were found in any of the responses to how satisfied individuals were with the way they had coped with the TEMPSC training. As with the responses to the other abandonment, combined smokers were less satisfied with how they coped with the TEMPSC training.*

![Diagram showing aspects of TEMPSC most difficult to cope with - refresher subjects]

**Figure 12a**
Aspect of TEMPSC most difficult to cope with - refresher subjects

![Diagram showing aspects of TEMPSC most difficult to cope with - combined subjects]

**Figure 12b**
Aspect of TEMPSC most difficult to cope with - combined subjects
Figure 13a
Most difficult TEMPSC exercise - refresher subjects

Figure 13b
Most difficult TEMPSC exercise - combined subjects
Figure 14a
How well subjects felt they coped with TEMPSC training - refresher

Figure 14b
How well subjects felt they coped with TEMPSC training - combined
3.3.5 Changes in emergency coping abilities

When questioned on their capabilities for evacuating offshore, subjects responded with a general pattern of improved personal perception of coping ability (see Figures 15a & 15b). These improvements were especially obvious among the combined responses, 98% (n = 45) feeling either moderately or much more able to evacuate safely from an offshore installation during an emergency than before the training course. No significant age related differences were found.

![Figure 15a](image)

**Figure 15a**
How much more capable subjects felt of safely evacuating from an emergency offshore - refresher

![Figure 15b](image)

**Figure 15b**
How much more capable subjects felt of safely evacuating from an emergency offshore - combined
A general increase in perceived ability to cope with a fire can be seen for refresher subjects in Figure 16a. According to the results of a Tukey's pairwise comparison test, the mean age of those refresherers who felt moderately more capable of coping with a fire, 42 years, was significantly higher than those who felt slightly more able to cope, 32 years. No continual age trend, however, was seen in the overall responses. Combined trainees showed a marked increase in how capable they perceived themselves, see Figure 16b. A total of 97% (n = 44) felt either moderately or much more able to cope.

![Graph 16a](image_url)

**Figure 16a**
How much more capable subjects felt of coping with a fire - refresher

![Graph 16b](image_url)

**Figure 16b**
How much more capable subjects felt of coping with a fire - combined
Refreshers generally felt more able to cope with a helicopter ditching (see Figure 17a). Their confidence in helicopter transport was, however, very obviously unchanged, 75% (n = 33) responding no change (see Figure 18a). Combined trainees showed a marked increase in their coping capabilities regarding helicopter ditching (see Figure 17b) 97% (n = 44) felt either moderately or much more capable. Confidence in helicopter transport also increased (see Figure 18b). Forty-nine per cent (n = 22) felt their confidence either somewhat or greatly increased, though approximately the same amount, 47% (n = 21), felt no change.
Figure 18a
Whether the training altered subjects' confidence in helicopter transport - refresher

Figure 18b
Whether the training altered subjects' confidence in helicopter transport - combined
From Figure 19a, it can be seen that refresher trainees considered their knowledge of survival techniques to have 30% (n = 13) slightly, 39% (n = 17) moderately, or 30% (n = 13) much improved, following the training course. This improvement, however, was not as marked as that shown by the combined trainees, 83% (n = 38) of who felt their knowledge was much improved. This was hardly surprising given that few had any experience of survival techniques before commencement of the course. The improvements in both groups, demonstrated that the course was beneficial to refreshers as well as combined, regarding learning techniques of survival in an offshore emergency.

![Figure 19a](image)

**Figure 19a**
Whether the course improved subjects' knowledge of survival techniques - refresher

![Figure 19b](image)

**Figure 19b**
Whether the course improved subjects' knowledge of survival techniques - combined
3.3.6 Expectations & actuality - physical & emotional

Following training, as seen in Figure 20b, combined trainees felt they would be 46% (n = 21) moderately or 54% (n = 25) much more able to cope in other emergency situations. A less pronounced effect was shown by refreshers (see Figure 20a). It thus appeared that the survival training course had positive effects on overall coping ability.

Figure 20a
Whether the training made subjects more able to cope with other emergency situations - refresher

Figure 20b
Whether the training made subjects more able to cope with other emergency situations - combined
The results plotted in Figure 21a were very balanced. The majority of refresher trainees did not receive any surprises regarding how physically demanding the training was. It should be noted, that as the training was rated more physically demanding, a slight, though not significant, increase in the age of the volunteers was detected. On observing the responses to how emotionally demanding the course was, Figure 22a, it was seen that for most refresher trainees their initial view of the training matched what they experienced. Eighty-six per cent (n = 38) of refreshers responded ‘as expected’.

As might have been anticipated, the combined subjects’ responses showed that their initial perception of the demands of training deviated more from the actual event than the refreshers (see Figures 21b and 22b). Following a Tukey’s paired comparison test to the responses of how physically demanding the course had been, those who rated somewhat less were found to be significantly younger, 30 years, than those who had chosen much more as a response, 49 years. A trend of gradually increasing age was again seen, but with combined subjects this occurred in response to whether the training course was as emotionally demanding as expected.

![Figure 21a](image)

**Figure 21a**

Whether the training was as physically demanding as expected - refresher subjects

![Figure 21b](image)

**Figure 21b**

Whether the training was as physically demanding as expected - combined subjects
Figure 22a
Whether the training was as emotionally demanding as expected
- refresher subjects

Figure 22b
Whether the training was as emotionally demanding as expected
- combined subjects
3.4 ANALYSIS OF THE STATE - TRAIT ANXIETY INVENTORY (STAI) RESULTS

The General linear model (GLM) approach to analysis of variance (ANOVA) was conducted on both the refresher and combined state anxiety inventory scores. Various factors were considered for their possible ability of affecting state anxiety scores:

- The variation between subjects was investigated by assigning every subject with a unique number, these numbers were referred to as 'subject' in the GLM.

- Each subject's age was also considered as a possible influencing factor. The term 'age' was also ran as a covariate. Average scores per event are shown in Figures 23a & 23b and 24a & 24b, with divisions according to age groupings.

- Comparisons were also made as to whether or not subjects smoked, 'smoke', and according to self-rated fitness, 'fit', and swimming ability, 'swim'.

- All the state anxiety scores were compared with each other according to which specific training activity they had preceded, or, if an early morning questionnaire, on which morning they had been completed, e.g. HUET, fire training, enrolment, morning 2, etc. This factor was referred to as the 'event'.

- The order, or sequence, in which subjects completed the various aspects of the course. Each score was assigned a number, 1 to 9 for combined and 1 to 6 for refresher, depending on whether the corresponding anxiety questionnaire had been completed first, second, third, etc. In the GLM, this factor was termed 'sequence' and ran as a covariate.

For refreshers, those subjects with one or more missing scores were extracted from the dataset (12 subjects in all). Mean STAI values of the total group are compared with those of the reduced subject group in Table 4. Additional analyses could then be conducted in the form of two-way ANOVA - unlike GLM, two-way ANOVA cannot be conducted with groups of data that contain missing values. The average event values were then used in a Tukey's wholly significant difference (WSD) test, this enabled determination of which events were significantly different from each other.

All scores, both combined and refresher, were given a single code according to when, and before which event they were recorded. This enabled the influence of the event and sequence effects to be considered in conjunction. A GLM analysis was subsequently carried out using these codes as a covariate of the STAI scores.
The values of major interest were the pre-event STAI scores. Hence the 45 refresher subjects with the full complement of pre-event scores were extracted for further analysis. GLM from first principles was conducted with subsequent orthogonal contrast calculations. The following orthogonal contrasts were conducted:

- linear contrast, to investigate whether the scores changed linearly with the day of the course on which the training had been carried out;
- quadratic contrast, when considering the same training activity, but conducted on different course days, to determine if anxiety scores showed a peak or trough pattern;
- HUET versus fire scores directly, to determine whether HUET and fire anxiety scores differed significantly;
- HUET & fire versus TEMPSC, to determine whether TEMPSC anxiety scores were lower than HUET or fire scores.

Whether a factor was significant or not, and how significant depended upon the p-value that was determined from the statistical analyses. The following groupings of p-values are referred to in the results with their respective symbols, p less than: 0.1 †, 0.05 *, 0.01 **, or 0.001 ‡. These values represent increasing levels of significance. (Actual p-values and coefficient values are contained in Appendix 6.) Refresher and combined subjects' results are presented separately.

3.4.1 Outcome of the refresher subjects' STAI analyses

As might have been expected, there was significant variation among the individual subjects' scores.

Age was found to have significant effect *. Furthermore, the value of the coefficient of age was negative, which suggests that average state anxiety scores gradually decreased as older individuals were considered. Mean age grouped scores were plotted (see Figures 23a & 23b) and a trend of decreasing state anxiety with age was seen. The possibility that age itself was not a direct causative agent was, however, investigated. It was hypothesized that younger individuals differed in some other aspect from older individuals, this other aspect being why age, as a factor, was shown to have a significant effect. Whether or not subjects smoked was, therefore, also analysed.

\[
p\text{-value } < 0.1 \, \dagger; \, < 0.05 \, *; \, < 0.01 \, **; \, < 0.001 \, ‡
\]
By determining the mean age of smokers, 37 ± 1 years, and non-smokers, 38 ± 1 years, it was seen that there was little difference. The age factor, therefore, was not an indirect result of whether subjects smoke. Nonetheless, smoking did have a highly significant effect on scores **. Again a negative coefficient value was calculated, implying that smokers manifested higher average state anxiety scores. When the trait anxiety levels were investigated, via one-way ANOVA and a Tukey's paired comparison, smokers had a significantly higher * mean trait anxiety inventory score, 36, than non-smokers, 32. It would therefore have been expected that their state anxiety scores also be higher. Possibly those people who smoked were more anxious than average as a personality trait, rather than as a result of their smoking, and this was manifested in their responses to the training.
The individual's self-rated fitness level was found to have a significant effect on anxiety scores *. The value of the coefficient suggested that as perceived fitness decreased, individuals scored higher in state anxiety. Self-rated swimming ability did not have a significant effect on the scores.

The sequence in which activities were conducted did not produce any significant effect on scores. Had the distribution of subjects among the different sequences been more uniform, a sequence effect may have been detected. A lack of significance may also have been a result of the short time span over which the refresher course was conducted, relative to the combined course. Table 3 contains the details of the various sequences as well as the number of subjects who followed each sequence.

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Refreshers</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>HAFT</td>
<td>8</td>
<td>21</td>
</tr>
<tr>
<td>AHFT</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>FHAT</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>PTHA</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>TAHF</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>THAF</td>
<td>22</td>
<td>7</td>
</tr>
<tr>
<td>TFAH</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>TFHA</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total: subjects</strong></td>
<td><strong>52</strong></td>
<td><strong>47</strong></td>
</tr>
<tr>
<td><strong>Total: sequences</strong></td>
<td><strong>5</strong></td>
<td><strong>7</strong></td>
</tr>
</tbody>
</table>

*Key:* H - HUET; F - Fire training; A - Abandonment to life raft; T - TEMPS

On conducting the GLM on all the state anxiety scores, the specific events were found to have a significant effect ‡. To determine between which particular exercises significant differences lay, further analyses were conducted. Two methods were used, as follows.

First, those subjects with incomplete data sets were extracted from the refresher group. Two-way ANOVA was carried out, the calculated means are shown in Table 4.

Table 4 shows that the mean values with 52 subjects differed little from the values calculated using Two-way ANOVA with 40 subjects. From the two-way analysis, both subject ** and event ** factors were again found to be significant. Mean values for the specific activities were subsequently used in a Tukey's WSD test. The outcome of this test is shown in Table 5.

\[ p\text{-value} < 0.1 \dagger; < 0.05 \ddagger; < 0.01 **; < 0.001 \ddagger \]
Table 4
Mean STAI values, according to event, for complete and reduced refresher subject groups

<table>
<thead>
<tr>
<th>Event</th>
<th>All 52 subjects Mean</th>
<th>40 subjects Mean</th>
<th>Difference in means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enrolment</td>
<td>34.41</td>
<td>33.42</td>
<td>-0.99</td>
</tr>
<tr>
<td>Morning 2</td>
<td>29.57</td>
<td>28.50</td>
<td>-1.07</td>
</tr>
<tr>
<td>Morning 3</td>
<td>28.46</td>
<td>27.65</td>
<td>-0.81</td>
</tr>
<tr>
<td>Fire training</td>
<td>38.27</td>
<td>37.17</td>
<td>-1.10</td>
</tr>
<tr>
<td>TEMPSC</td>
<td>30.96</td>
<td>31.23</td>
<td>+0.27</td>
</tr>
<tr>
<td>HUET/Aband</td>
<td>38.50</td>
<td>37.40</td>
<td>-1.10</td>
</tr>
</tbody>
</table>

The minimum difference value was calculated as 5.956. Any difference above this was deemed significant, at the 5% level. It was found, as seen in Table 5, that mean state anxiety scores prior to the fire training were significantly more than those obtained on the 2nd and 3rd morning, and close to being significantly more than the mean score prior to the TEMPSC. Further, the mean scores prior to the HUET were significantly more than the 2nd and 3rd morning scores and the pre-TEMPSC scores. The enrolment score was close to being significantly more than the 3rd morning score.

Table 5
Tukey's wholly significant difference test on refresher. STAI results (complete data sets only)

<table>
<thead>
<tr>
<th>Event</th>
<th>Morn 3</th>
<th>Morn 2</th>
<th>TEMPSC</th>
<th>Enrol</th>
<th>Fire</th>
<th>HUET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>27.65</td>
<td>28.50</td>
<td>31.23</td>
<td>33.42</td>
<td>37.17</td>
<td>37.40</td>
</tr>
</tbody>
</table>

* indicates significance at the 5% level

The second form of investigation, to determine between which events significant differences lay, involved setting up a code for each event/sequence combination. This enabled event and sequence effects to be considered simultaneously, from the whole group's scores. Table 6 shows the effect values, taken from GLM, and the number of subjects who carried out the particular exercises on the specified day.

All refreshers completed the 3 morning state anxiety scores at the same stage of the course, that is on day 1, 2 and 3. Furthermore, their 2nd and
3rd morning values were clearly different from the pre-event values (see Table 6). The pre-event values were therefore investigated independently for any sequence related differences.

Table 6
Whole group refresher STAI values according to the event and the day of the course

<table>
<thead>
<tr>
<th>Event</th>
<th>First day</th>
<th>Second day</th>
<th>Third day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Effect</td>
<td>Number</td>
<td>Effect</td>
</tr>
<tr>
<td>Enrol</td>
<td>34.37</td>
<td>51</td>
<td>29.63</td>
</tr>
<tr>
<td>Morn 2</td>
<td>37.18</td>
<td>7</td>
<td>39.44</td>
</tr>
<tr>
<td>Morn 3</td>
<td>32.60</td>
<td>37</td>
<td>31.56</td>
</tr>
<tr>
<td>Fire</td>
<td>38.82</td>
<td>8</td>
<td>38.53</td>
</tr>
<tr>
<td>TEMPSC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HUET</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GLM was conducted on the anxiety scores from the 45 subjects with all 3 pre-event values. The effect values obtained from this analysis (see Figure 24) were then used in orthogonal contrasts. Contrasts enable the 'event' or effects of the HUET and abandonment, fire training and TEMPSC, and the 'order' or day of the course that the training was carried out, to be separated.

No significant difference was found in the sequence that activities were carried out, nor between HUET and fire training scores. It was determined, however, that TEMPSC scores were significantly lower than both HUET and fire training scores. On viewing Figure 24, these differences are apparent.

![Figure 24](image)

Refresher pre-event state anxiety effect values (45 subjects)
3.4.2 Outcome of the combined subjects' STAI analyses

As with the refresher data, according to GLM, subjects' STAI scores varied significantly.

From the GLM analysis, actual age was not found to have a significant effect on STAI scores. This agrees with the lack of a consistent pattern in Figures 25a & 25b, which show STAI values plotted according to age group. It was proposed that any age effect would have been connected to experience. As few of the combined subjects would have had any experience of survival training, age might therefore have been expected to have no significant effect.

![Figure 25a](image)

Combined subjects morning state anxiety scores according to age group

![Figure 25b](image)

Combined subjects pre-event state anxiety scores according to age group
Whether or not combined subjects smoked did not result in significant differences in STAI scores. Further, no relationship was found between trait anxiety score and whether or not subjects smoked. This concurred with the suggestion that state anxiety inventory scores were related to the individual's trait anxiety score.

Self-rated fitness was found to have a significant effect on STAI scores \( \dagger \). According to the coefficient value, STAI scores were higher for those who rated themselves less fit. Self-rated swimming ability also resulted in significant differences in anxiety scores \( \ddagger \), the coefficient value indicated that those who rated themselves less able to swim scored higher in the anxiety inventory.

Although, unlike self-rated fitness and swimming ability, age did not produce significant differences, it should be noted that the age recording was an absolute value, whereas the former were self-rated. The former could, therefore, have been a reflection of the individual’s confidence in their own abilities, rather than a true indication of fitness and swimming ability.

When all the anxiety scores were considered together, the sequence in which events were conducted was found to have a significant effect \( \ddagger \). Furthermore, the coefficient value was negative, which demonstrated that STAI scores, as a whole, decreased as the week progressed. Seven different sequences of the combined course were observed (see Table 3).

GLM conducted on all state anxiety scores, revealed that there were significant differences between events \( \ddagger \). Mean values for each event are shown in Table 7. As the number of combined subjects with complete STAI data sets, 26, was considerably smaller than the whole group, a Tukey’s WSD test was not conducted.

<table>
<thead>
<tr>
<th>Event</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enrolment</td>
<td>38.15</td>
<td>10.63</td>
</tr>
<tr>
<td>Morning 2</td>
<td>30.72</td>
<td>7.91</td>
</tr>
<tr>
<td>Morning 3</td>
<td>29.47</td>
<td>8.28</td>
</tr>
<tr>
<td>Morning 4</td>
<td>30.80</td>
<td>9.93</td>
</tr>
<tr>
<td>Morning 5</td>
<td>28.45</td>
<td>6.69</td>
</tr>
<tr>
<td>HUET</td>
<td>42.26</td>
<td>12.02</td>
</tr>
<tr>
<td>Abandonment</td>
<td>39.31</td>
<td>11.27</td>
</tr>
<tr>
<td>Fire training</td>
<td>40.77</td>
<td>10.38</td>
</tr>
<tr>
<td>TEMPSN</td>
<td>32.51</td>
<td>7.77</td>
</tr>
</tbody>
</table>

p-value < 0.1 \( \dagger \); < 0.05 \( * \); < 0.01 \( ** \); < 0.001 \( \ddagger \)
The highest scores were recorded before the HUET, followed by the pre fire training and pre abandonment scores (see Figure 26). Regarding the early morning STAI scores, the general impression from the combined scores was that, following the high enrolment value, the morning scores dropped to a steady plateau.

![Graph](image)

**Figure 26**
Comparison of mean refresher and combined state anxiety scores

As with the refresher scores, analysis was conducted using a code for each event and sequence combination. The effect of sequence and event considered together was found to be significant. Effect values are shown in Table 8. The combinations of event and sequence were considerably more complex than that seen in the refreshers, compare with Table 6. Orthogonal contrasts were therefore not conducted. Thus, where the specific differences lay was not determined.
<table>
<thead>
<tr>
<th>Event</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>5th</th>
<th>6th</th>
<th>7th</th>
<th>8th</th>
<th>9th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enrol</td>
<td>38.15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morn 2</td>
<td>35.55</td>
<td>30.52</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morn 3</td>
<td></td>
<td>28.67</td>
<td>28.81</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morn 4</td>
<td></td>
<td></td>
<td></td>
<td>31.94</td>
<td>28.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morn 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>28.29</td>
</tr>
<tr>
<td>HUET</td>
<td>43.37</td>
<td>40.43</td>
<td>44.78</td>
<td>41.47</td>
<td>37.88</td>
<td></td>
<td></td>
<td></td>
<td>47.57</td>
</tr>
<tr>
<td>Abandon</td>
<td>42.72</td>
<td>38.39</td>
<td>38.83</td>
<td>45.54</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>31.88</td>
</tr>
<tr>
<td>Fire</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>41.67</td>
<td>38.87</td>
</tr>
<tr>
<td>TEMPSC</td>
<td>36.85</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>28.21</td>
<td></td>
<td>30.70</td>
</tr>
</tbody>
</table>

The main reason why Table 8 was more complex than Table 6 was that, unlike the refresher course, the fire fighting training was completed over 2 days in the combined course. The single, representative fire training event investigated occurred on day 2 of the combined course fire training. If subjects completed the fire training at the start of the course, the first STAI was completed at enrolment, the second on the morning of day 2, and the third prior to the fire training event. If subjects did not undertake the fire training at the start, the first STAI was completed at enrolment, the second prior to the event on day 1, and the third on the morning of day 2. This resulted in the morning STAI scores from days 2, 3 & 4 being completed at 2 different points in the overall sequence. Full investigation of the sequence effect would therefore not be possible if the day of completion only was considered.

3.4.3 Comparisons of refresher and combined subjects' STAI results

Age was found to have a significant effect on STAI scores, but only in the refresher group. It was proposed that this was simply a result of the older refresher subjects having attended more survival courses, in other words having more experience. If this proposal were correct, the lack of an age effect in the combined subjects would have been expected, as few of the subjects would have had any experience of survival training, no matter what their age.

Refresher subjects who smoked had higher inherent anxiety than their non-smoking counterparts. Why this relationship was not found in the combined subject group was not immediately apparent.

Self-rated fitness was found to have a significant effect on both refresher and combined subjects' STAI scores. STAI scores were higher for those who rated themselves less fit.

Unlike refresher, when all the anxiety scores were considered together, the sequence in which events were conducted was found to have a significant effect on combined subjects' STAI scores. This effect, of
decreasing STAI scores over the duration of the week, may not have been detected in the refreshers because the course was just 3 days in length.

In Figure 26, all the overall combined scores can be seen to be higher than the comparable refresher scores. It was also interesting to note that the final morning scores, i.e. morning 3 for refreshers and morning 5 for combineds, resulted in virtually the same score.

3.5 RELATIONSHIPS AMONG STAI SCORES, EVALUATIONS OF THE COURSE AND OUTCOME PERCEPTIONS

Analyses were conducted to determine if subjects' perceived self coping abilities were reflected in their anxiety scores. This took the form of one-way ANOVA, with Tukey's paired tests. (The latter were conducted to a 5% significance level.) Analyses were carried out between responses to the post activity evaluation questionnaires and the relevant state anxiety inventory scores, and between the perceived outcome responses and the relevant state anxiety scores.

3.5.1 Relating to HUET and abandonment to life raft training

The Tukey's test indicated that the mean state anxiety score of those refreshers who rated general anxiety as the most difficult aspect of the HUET to cope with, 46.7, was close to being significantly higher than the anxiety score of those who rated swimming, breath holding, seat belt release, and finding the exit, considered together, 35.6. The former group were also close to significantly higher than those who rated disorientation, 36.4, but not different from those who rated remembering instructions. There were, however, only 2 refreshers who found remembering instructions the most difficult aspect. No connection was found between refreshers pre-HUET anxiety scores and their rating for satisfaction of coping with the HUET training. Following a Tukey's comparison test, a significant difference was found, however, between the scores of those who felt more capable of coping with a helicopter ditching, 32.0, and those who felt no change, 47.0, following training. Thus, individuals with lower pre-HUET anxiety scores demonstrated greater improvements in self-coping ability, than those with higher pre-HUET anxiety scores. A relationship was also found between trainees' confidence in helicopter flight, following training, and their anxiety scores, though only at the 10% level. Pre-HUET anxiety scores were found to gradually increase as confidence in helicopter transport decreased.

On assessing combined subjects' data, significant differences in anxiety scores were found according to how satisfied subjects were with the way they coped with the HUET training. According to the Tukey's paired comparison test, those who were somewhat satisfied with the way they coped, scored significantly higher, 65.7, than those who coped well, 43.6, and than those who coped very well, 39.0. No significant effects were
discerned accompanying changes in capability of coping with a helicopter ditching, nor with changes of confidence in helicopter transport.

Significant differences were found on relating combined subjects' anxiety scores prior to the abandonment to life raft with how well subjects felt they had coped with the exercise. A Tukey's test demonstrated that those who were very well satisfied with the way they had coped scored significantly lower, 32.9, than those who had coped well, 42.9. No relationship was found between pre-abandonment anxiety scores and perceived ability of coping with emergency evacuations in future.

3.5.2 Relating to fire training

As very few individuals rated general anxiety as the most difficult aspect of the fire training, no correlations were conducted between these responses and the fire training anxiety scores. For refreshers, a Tukey's test demonstrated that those who were very well satisfied with the way they had coped with the fire fighting training, scored significantly lower, 34.4, than those who were somewhat satisfied, 48.8. A significant difference was also found in the combined subjects' responses *. Those who felt very well satisfied with the way they had coped scored significantly lower, 37.4, than those who felt they had coped well, 45.9, according to a Tukey's comparison test. Pre-fire training anxiety scores were not found to be related to future ability of coping with a fire for refresher or combined subjects.

3.5.3 Relating to TEMPSF training

Only 1 subject rated general anxiety as the most difficult aspect of the TEMPSF training to cope with. ANOVA was therefore not conducted between these responses and the TEMPSF anxiety scores. Satisfaction with how well subjects coped with the TEMPSF training was, however, analysed, and significant differences were found. A general trend of increasing anxiety scores, with decreasing satisfaction in level of coping was observed in the refresher results. The Tukey's test indicated that those who were very well satisfied scored significantly lower, 28.1, than those who were somewhat satisfied, 39.7. A similar result was found in the combined data. Those who felt very well satisfied with the way they had coped scored significantly lower, 29.8, than those who were well satisfied, 35.6.

3.6 PERSONALITY SCORES

The two personality questionnaires administered were Rotter's Locus of control scale, and Zuckerman's Interest and Preference test, or Sensation Seeking Inventory. The refresher and combined subjects' scores for these scales are presented in Table 9.

p-value <0.1 †; <0.05 *; <0.01 **; <0.001 ‡
The scores in Table 9 were correlated against age. It was found that older subjects were significantly more internally oriented in both the refresher and combined subject groups*. Significant correlations with age were only found in the disinhibition subscale of the Interest & Preference test *. Older subjects had lower disinhibition scores. The reference values in Table 9, showed that the subject population in this study had personality scores comparable with other local populations.

No consistent correlations were found between the two personality questionnaires. This agreed with Zuckerman's findings in American college students (1979).

<table>
<thead>
<tr>
<th>Questionnaire</th>
<th>Refresher</th>
<th>Combined</th>
<th>Reference values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>St dev</td>
<td></td>
</tr>
<tr>
<td>Locus of Control &amp; Interest &amp; Preference:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>21.6</td>
<td>6.7</td>
<td>21.2</td>
</tr>
<tr>
<td>Thrill &amp; adventure seeking</td>
<td>6.8</td>
<td>2.6</td>
<td>6.6</td>
</tr>
<tr>
<td>Experience seeking</td>
<td>5.3</td>
<td>1.8</td>
<td>5.2</td>
</tr>
<tr>
<td>Disinhibition</td>
<td>5.5</td>
<td>2.4</td>
<td>5.7</td>
</tr>
<tr>
<td>Boredom</td>
<td>4.0</td>
<td>2.1</td>
<td>3.8</td>
</tr>
</tbody>
</table>

A low locus of control score is indicative of internal orientation, while a high score is indicative of external orientation (see section 2.1.2).
* Offshore workers (Sutherland & Cooper, 1985)
§ University of Aberdeen undergraduates (Blackman, in Zuckerman, 1979)

3.7 DISCUSSION OF DEMOGRAPHIC AND EVALUATION RESULTS

A group of 99 subjects, randomly selected from across a wide age range, volunteered and subsequently were monitored during their offshore survival course. The sample population were split into 2 groups according to the training course attended, 3 day basic refresher, or 5 day combined survival and fire fighting course.

The majority of refreshers had experience of working offshore, and of all four of the training activities considered in detail in the study. Although almost half of the combined subjects had worked offshore, generally less than one third had experience of any of the four exercises. The self-rated fitness and swimming ability profiles were similar for refresher and combined subjects, with a general bias towards an "adequate" level.
Initially subjects perceived that the HUET and fire fighting training would be the most difficult. The HUET was found to be especially prominent within the combined group. It thus seemed likely that apprehensions were fostered before the course. Some means of reducing these predominantly unjustified anxieties would seem appropriate. This could take the form of supplying more extensive information to individuals before starting the course. Alternatively, a short, realistic summary of the course contents could be delivered at enrolment. The TEMPS training were consistently considered the easiest activity.

Out of the possible range of difficulties, it was the physical, in the form of smoke, as opposed to the psychological aspects that were felt to be difficult within the fire training. That smoke was rated as the most difficult was reflected in the exercises that were perceived to be the most difficult. Any modifications to training would therefore seem most appropriately applied to the smoke. One possibility would be to decrease the smoke contact. This could be achieved by donning BA sets outside the smoke filled atmosphere. A more direct approach would be to carry out the self-rescue exercise in a hot, dark atmosphere, but without the smoke. The heat and reduced visibility would therefore still be present, and an initial smoke appreciation within the combined course may still be considered relevant, but the smoke contact would be reduced.

Regarding helicopter underwater escape training, disorientation proved to be the major source of difficulty for both refresher and combined subjects. As disorientation appeared so prominently, and was experienced by trainees who had undertaken the training previously, as well as those new to the HUET, perhaps it should be given more consideration within the training schedule. Various possibilities exist for helping to overcome disorientation. An initial capsize could be carried out with trainees wearing goggles, thus facilitating the process of familiarisation. Trainees could be given the option of taking part in more than 2 capsizes. This could be supplemented with more individual tuition. To obtain the most from this, instructors would be required to give trainees feedback on the actions that were performed correctly, and those that require adjustment.

The responses to the life raft abandonment did not show any particular source of difficulty, though tasks such as entering and righting the raft and climbing scramble nets were clearly found to be physically demanding. On considering fitness, those refreshers who rated the scramble net as most difficult, also rated themselves as less fit, compared to the other subjects' self-ratings. It should be noted that scramble nets have since been taken out of the refresher course.

No particular problems were encountered with the TEMPS training. Comments were made, however, regarding the length of time spent on the
sea trip. Some subjects felt that this time could have been spent more usefully.

Overall, there was a very positive picture of the subjects feeling more able to cope with various emergencies. Although the increases were most marked in the combined group, that the refresher felt improvement implied that benefits could be obtained from repeating training. Additional benefits were seen in that improvements in coping ability were perceived as being able to be carried over to other emergency situations. These improvements all indicated that the training provided was effective in increasing the individuals' confidence in their own abilities, and at enhancing perceived knowledge of survival techniques. Future studies could incorporate objective measures of performance to enable more direct assessment of training outcomes.

Anxiety scores were found to vary significantly among the different subjects, for both refresher and combined. This would normally be expected, especially for a population taking part in a demanding course.

An age related decrease in anxiety was observed in refresher subjects. Older refresher may have been expected to have more experience of survival training than their younger counterparts, which would have resulted in an increased feeling of control and ultimately decreased anxiety. Yet, although this age effect was considered to be primarily the result of experience, age related changes in state anxiety scores have been detected previously by Spielberger et al (1983). He found that scores for those over 50 tended to be lower in both state and trait anxiety. Generally, however, Spielberger found resting values to be "remarkably consistent" across a wide age range. Despite the reduction in anxiety felt by the older refresher, within the responses to the perceived outcome questionnaire, there was a general trend of older individuals experiencing greater physical and emotional demands than expected. This suggests that older individuals did find the survival training more demanding, even though their manifest anxiety was lower.

A positive relationship was found between smoking and level of anxiety, but only within the refresher group. No consistent smoking effect pattern was detected within the responses to the evaluation questionnaires, although the significant effects that were found indicated that smokers were less satisfied with the way they coped with training. The general impression therefore was that non-smokers were likely to experience less anxiety, and cope better with offshore survival training than smokers.

For all subjects, lower self-rated fitness was related to higher anxiety scores. This agreed with the work of Brooke and Long (1987) who provided further evidence for the proposal that higher levels of physical fitness contribute to the ability to cope more efficiently. Higher anxiety
scores can ultimately be considered as an indication of a lower coping ability. The ratings of fitness referred to here were, however, the individual's perceived fitness level, which may not have been related to their actual physical fitness. These recordings may have, however, been suitable in this instance, as both self-rated fitness and anxiety involved the individuals' perception of themselves. Stress and anxiety have been argued as being related to the individual's perception of their own abilities (Cox 1985).

Swimming ability was found to be related to combined subject's anxiety scores, non-swimmers demonstrated the greatest pre-event anxiety. This was not entirely surprising, given the amount of water based activities, and the combined subjects' lack of previous experience, and therefore susceptibility to exaggerated accounts of the course content. Further indications that apprehensions built up prior to the course contributed significantly to elevating anxiety scores, were found within the combined data. A significant sequence effect was detected, indicating that the combined trainees were at their most anxious at the beginning of the course.

Analysis of the refresher anxiety scores showed that the pre-HUET and pre-fire training scores were significantly greater than all the other recordings, except the enrolment anxiety score. A very similar pattern was established in the combined group, though their pre-event and enrolment scores tended to be higher than the equivalent refresher recordings. Spielberger, referring to recordings from over 1300 American working males, cited resting anxiety values of around 35. It would thus seem that the values obtained early in the morning of around 30 and those prior to the less demanding exercises were reasonably low (see Tables 4 & 7). The HUET, fire fighting, and enrolment scores, and abandonment for the combined subjects, were within the range of values obtained from individuals taking part in free-fall lifeboat training (Hytten et al, 1990). Mean anxiety scores ranged from 35.5 (± 6.7) on the first fall up to 37.4 (± 11.3) on their third fall. Overall anxiety values in the present study were found to be elevated prior to the more demanding exercises, but not anymore than has been observed in other related training situations.

That the higher of the anxiety scores were further elevated in the combined group, and that the morning values demonstrate an initial peak, then dropping to a plateau, provides further evidence for the previously made suggestion that a large contributor to the anxiety experienced by individuals new to training resulted from pre-course apprehensions.

For all but the refresher post HUET evaluation, greater self-satisfaction with the way individuals coped with the training was found to be associated with lower pre-event anxiety scores. Also, refreshers who perceived the greatest improvements in their ability of coping with a
perceived the greatest improvements in their ability of coping with a helicopter ditching in future, and increased confidence in helicopter transport, scored the lowest in the pre-HUET anxiety. This agreed with the findings from a study on underwater escape training at NUTEC, where:

"Perceived training effect was found to be inversely related to anxiety during training." (Hyttten, Jensen & Vaernes, 1989)
4.0 RESULTS AND DISCUSSIONS II

4.1 PHYSIOLOGICAL REACTIONS - HEART RATE

Heart rate (HR) data was downloaded directly into a computer without any significant problems. Codes, which had been established for subjects, individual course days, and activities, were adapted for use in labelling heart rate recordings. Heart rate recordings could be viewed as continual traces. A trace from one subject's exercise test is shown (Figure 28), as well as typical traces for each of the selected exercises (e.g. Figure 29). The sections of these traces that were analysed most closely are described. Averages were calculated for before, during, and after the 4 training exercises. Resting heart rate and the level attained at each workload were calculated from the exercise test. The minimum period for analysis was set at 1 minute.

Means were calculated for each interval, considering refresher and combined subjects separately, and according to age group. Values for each of the training exercises are shown in graphical form under the relevant headings. Whole group means are also given in Tables 10 to 13.

Subsequently, t-tests of the paired differences between the pre-event recording, treated as the baseline, and the during and post-event heart rates were conducted, for each event. Whether differences were significant or not, and how significant depended upon the p-value determined from the t-tests. The following groupings of p-values are referred to in the results with their respective symbols, p less than: 0.1 †, 0.05 *, 0.01 **, or 0.001 ‡. These values represent increasing levels of significance. (See Appendix 7 for actual p-values.)

4.1.1 Aerobic fitness test

The trace in Figure 28 shows that the heart rate reached a plateau at each of the workloads. Means were taken from these "steady state" periods. Mean resting heart rates for refresher and combined subjects are plotted according to age group in Figure 27.

p-value <0.1 †; <0.05 *; <0.01 **; <0.001 ‡
From Figure 27 it can be seen that resting heart rate values were very similar, both between the 2 training groups, and among the different age groups. The combined 30's appeared to have lower mean values. One-way ANOVA, of heart rate against age code, did demonstrate that the combined 30's group were close to being significantly lower in resting heart rate than the combined 40's group †. None of the other groups, however, were significantly different. There may have been some factor, other than age, that had resulted in these differences. This possibility seems likely given that age is a continuous variable and no continuous trend effect was observed. Overall, it appeared that age had no significant effect on resting heart rates, for this sample population. This had implications for the changes in heart rate seen during the training course. Specifically, when considering the levels of heart rate attained during the training, account did not have to be taken for initial differences in resting heart rate due to age.

The heart rates reached during the remainder of the exercise test are not presented here. Interested readers can, however, refer to Harris (in preparation).
Figure 28

Heart rate trace from one subject during the aerobic fitness test.

During the first 5 minutes of the trace the subject was seated at rest. The first step, up to 7½ minutes, represents the time the subject spent cycling with no resistance on the ergometer flywheel. This subject's initial work load was 50 watts, the third section in the trace, during which a plateau was reached within the first minute. The last workload was 75 watts, up to approximately 16 minutes. This last workload resulted in a more gradual increase to a plateau. The final section shows the subject's heart rate during the recovery period.
Heart rate trace from a refresher subject during the self-rescue fire training exercise. This trace is spread over 80 minutes; hence, although there is a considerable amount of variation, the initial impression of rapid changes in heart rate is primarily a result of the relatively large time scale. The first 10 minutes of the trace, from time 10 to 20 minutes, represent the subject's heart rate during the smoke house brief. The trainees then left the classroom and assembled outside of the smokehouse. This subject undertook the self-rescue exercise from time 43 to 50 minutes. An initial rapid increase in heart rate was observed. Following completion of the exercise, trainees removed their protective clothing. This subject's heart rate remained elevated during this time.
4.1.2 Fire Fighting Training

Figure 29 shows the recording taken during the self-rescue brief and exercise from the same subject who’s exercise test trace was shown earlier. The sections of heart rate analysed (see Table 10) were:

- Heart rate average for 1 minute steady state while viewing the smokehouse layout slide. This was during the brief for the smokehouse self-rescue exercise, which was conducted using breathing apparatus (BA).
- Heart rate average during the smoke BA exercise, from entering to exiting the smokehouse.
- Heart rate average for 1 minute steady state, taken within 3 minutes of exiting the smokehouse.

There was a considerable amount of variation, as can be seen from the numerous peaks and troughs in Figure 29. The impression of rapid changes in beats per minute (bpm), however, is primarily a result of the relatively long time scale on the graph. The rates during the brief, the first 10 minutes of the trace, appeared elevated above normal resting values. The values attained during the self-rescue exercise itself, from time 43 minutes to time 50 minutes, were comparable with the values obtained at the final exercise test workload, 75 watts for this subject 1. The heart rates reached during the self-rescue exercise, mean of 129 bpm, were below those that would be expected during an aerobic exercise session. Finally, it was noted that this subject’s heart rate during the self-rescue exercise was comparatively similar to the level reached whilst removing the protective clothing, following completion of the exercise.

The graphs in Figures 30a & 30b show HR means during the self-rescue using BA exercise. Mean values were virtually identical for refresher and combined subjects. Similarly, very little difference was discerned among the different age groups. The 50’s groups did appear slightly lower. The 50’s groups did contain smaller numbers, however, so the apparent difference may have been artificial.

Generally, the pre-event HR values were slightly elevated compared to the resting recordings. A large increase occurred during the self-rescue exercise itself. Heart rates fell after subjects had exited the smokehouse, though not returning to the baseline level. A return to baseline would not normally have been expected so soon after completion of the exercise.

1If the subject were to commence on a fitness program, using Karvonen’s formula (see Lamb, 1984), he would be advised to aim for a minimum training heart rate of 147 bpm. (This was calculated with the subject’s resting heart rate of 74 bpm, and a maximum heart rate of 220 minus age, therefore 196 bpm. Minimum training heart rate equals the resting heart rate plus 60% of the difference between the maximum and resting heart rates.)
The paired difference tests showed that both the during and post event values were significantly higher than the pre-event heart rates †. The mean increases were very similar for refresher and combined subjects. Of all the events the largest changes were recorded during the self-rescue training exercise (see Figures 31a & 31b).

Table 10  
Whole group mean heart rates during the self-rescue from the smokehouse, using BA

<table>
<thead>
<tr>
<th>Stage of activity</th>
<th>Refresher HR (bpm)</th>
<th>Combined HR (bpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Stan devn</td>
</tr>
<tr>
<td>Fire exercise:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before</td>
<td>92</td>
<td>15</td>
</tr>
<tr>
<td>During</td>
<td>139</td>
<td>19</td>
</tr>
<tr>
<td>After</td>
<td>123</td>
<td>20</td>
</tr>
</tbody>
</table>

p-value < 0.1 †; < 0.05 *; < 0.01 **; < 0.001 ‡
Figure 30a
Combined subjects' heart rate means during the fire exercise
- self-rescue from the smokehouse, using BA

Figure 30b
Refresher subjects' heart rate means during the fire exercise
- self-rescue from the smokehouse, using BA
Key: ■ HR during event minus HR before event
△ HR after event minus HR before event

Figure 31a
Refresher subjects' mean paired heart rate differences

Key: ■ HR during event minus HR before event
□ HR during capsize exercise of HUET minus IIR before
△ HR after event minus HR before event

Figure 31b
Combined subjects' mean paired heart rate differences
4.1.3 HUET

As the refresher and combined courses differed in the extent and order of the HUET exercises, traces from subjects on each of these courses are shown (see Figures 32a & 32b). Note that the time scales are different. Also, unlike the refresher course, the HUET exercises on the combined course were split into 2 sessions, with trainees waiting at the pool side in between. The slow and fast capsize occurred at 46 and 48 minutes respectively for the combined course subject (see Figure 32a). The time of the fast capsize coincided with the highest peak in heart rate for that subject. The surface impact simulation, the partial submersion, and the fast capsize occurred at 37, 39, and 42 minutes respectively for the refresher course subject (see Figure 32b). Peaks in that subject's HR were seen to correspond with the partial submersion and the capsize, both of which involved the subject being submerged.

The sections of heart rates analysed (see Table 11) were:

All subjects:
- Heart rate average over 5 minutes immediately after commencement of the HUET brief (this was not calculated during a video showing, nor during the demonstration of the impact position) - 'Brief'.
- Heart rate average over 1 minute steady state immediately prior to entering the water for the HUET exercises - 'Before'.

Combined subjects:
- Heart rate average during surface impact and partial submersion exercises, from entering the water to surfacing after the submersion - 'Upright exercises'.
- Heart rate average during slow and rapid capsizes, from entering the water to surfacing after the final exercise - 'Capsizes'.

Refresher subjects:
- Heart rate average during refresher HUET exercises (surface impact, partial submersion and rapid capsize), from entering the water to surfacing after the final exercise - 'Upright exercises and rapid capsize'.

All subjects:
- Steady state heart rate average immediately post HUET exercises - 'After'.
The graphs in Figures 33a & 33b show HR means during the HUET brief and exercises. Again values were very similar for refresher and combined subjects, although this was slightly less obvious than during the fire training due to the differences in HUET training procedures. Mean values obtained during the HUET brief appeared higher than the mean resting values calculated from the aerobic exercise test. This suggested that individuals experienced some kind of activation. As they were seated "at rest" at this time, it would appear that this activation was psychological. The post values did not appear to return to the baseline. This was explained by the fact that trainees were still in the water at the time of the post exercise recording. As the subjects were observed in a situation where training was taking place, the ideal "resting" post value could not be obtained.

Again paired difference t-tests demonstrated that the during and post event HR values were significantly greater than the pre-event HRs †. The mean increases appeared greater in the refresher group, though no direct statistical comparisons were made between the two groups due to the variations in the training program. The HRs attained by the combined subjects during the 2 capsizes were found to be significantly greater than those achieved during the surface impact and partial submersion **.

<table>
<thead>
<tr>
<th>Table 11</th>
<th>Whole group mean heart rates during the HUET exercises</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage of activity</td>
<td>Refresher HR (bpm)</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>HUET:</td>
<td></td>
</tr>
<tr>
<td>Brief</td>
<td>82</td>
</tr>
<tr>
<td>Before</td>
<td>95</td>
</tr>
<tr>
<td>Upright exercises</td>
<td></td>
</tr>
<tr>
<td>Capsizes</td>
<td></td>
</tr>
<tr>
<td>Upright exercises &amp; rapid capsize</td>
<td></td>
</tr>
<tr>
<td>After</td>
<td>119</td>
</tr>
</tbody>
</table>

p-value < 0.1 †; < 0.05 *; < 0.01 **; < 0.001 ‡
Figure 32a

Heart rate trace from one subject during the combined HUET exercises.

The increases at the start of the trace correspond to the subject descending a set of stairs. This was followed by a period of relatively constant heart rate as the subject waited at the poolside, prior to entering the pool at time 44 minutes. As the combined course was split into 2 sessions, with trainees waiting at the poolside in between, the recording during the surface impact and partial submersion are not shown for this subject. The slow and fast capsizes occurred at 46 and 48 minutes respectively. A rapid rise in heart rate, the smaller of the 2 peaks just before 50 minutes, occurred as the subject swam to the surface after the rapid capsize.
Figure 33b

Heart rate trace from one subject during the refresher HUET exercises

The trace shows the subject's HR on entering the water at time 33 minutes, a general elevation in heart rate occurred at this time. HR then fell while the subject waited to enter the HUET. The surface impact simulation, the partial submerison, and the fast capsize took place at 37, 39, and 42 minutes, respectively. HR peaks in the trace thus corresponded with the partial submerison and the capsize, both of which involved the subject being submerged.
Figure 33a
Combined subjects' heart rate means during the HURF

Figure 33b
Refrshers subjects' heart rate means during the HURF
4.1.4 Abandonment to life raft

Figure 34 shows one subject's HR trace recorded during the abandonment to life raft exercise. At the start there was a gradual increase in HR followed by a relatively elevated HR throughout. The constant elevation could have been expected given the physical nature of the exercise. (The apparent drops in HR to zero were artefacts, probably due to loss of contact of the sport tester electrodes with the subject's skin.)

The sections of heart rate analysed (see Table 12) were:

- Heart rate average for 1 minute steady state pre-abandonment.
- Heart rate average during abandonment, from the siren sounding to the individual exiting the life raft.
- Heart rate average for 1 minute steady state during abandonment debrief.

The changes in HR appeared very similar for refresher and combined subjects (see Figures 29a & 29b). The combined subjects' pre-event means were, however, higher than the refresher subjects' (see Figures 35a & 35b). It should be noted that subjects were standing whilst awaiting the signal to abandon, and therefore were not totally at rest. The combined 20's group's HR during the exercise appeared relatively high. This may have been because the younger subjects volunteered as leaders, which involved additional physical activities such as righting upturned life rafts, therefore resulting in higher heart rates.

The paired difference t-tests showed that post event HR values were lower than the pre-event HRs for combined subjects only **. This was probably a result of the apparently higher combined pre-event means. Such elevation may have been due to apprehension of the unknown on the part of combined subjects. The HRs during the event were significantly greater than the pre-event values for both refresher and combined subjects ††.

<table>
<thead>
<tr>
<th>Table 12</th>
<th>Whole group mean heart rates during the abandonment exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage of</td>
<td>Refresher HR (bpm)</td>
</tr>
<tr>
<td>activity</td>
<td>Mean</td>
</tr>
<tr>
<td>Abandonment:</td>
<td></td>
</tr>
<tr>
<td>Before</td>
<td>103</td>
</tr>
<tr>
<td>During</td>
<td>135</td>
</tr>
<tr>
<td>After</td>
<td>105</td>
</tr>
</tbody>
</table>

p-value <0.1 †; <0.05 *; <0.01 **; <0.001 ††
Heart rate trace from a combined course subject during the abandonment to life raft exercise

A briefing for the exercise was delivered, finishing at time 35 minutes. The siren signalling the start of the exercise sounded at time 41 minutes. An initial increase in HR occurred as the subject proceeded upstairs to the platform. The subject stepped off the platform at time 45 minutes, HR again rose as the subject swam to and boarded the life raft. The exercise was completed at time 54 minutes, when the subject exited the life raft and returned to the muster area for a debrief. (The apparent drops in HR to zero were artefacts, probably due to loss of contact of the sport tester electrodes with the subject's skin.)
Figure 35a
Combined subjects' heart rate means during the abandonment exercise

Figure 35b
Refresher subjects' heart rate means during the abandonment exercise
4.1.5 TEMPSC

The initial part of the trace in Figure 36 was recorded during the TEMPSC brief, from time 10 to time 20 minutes. Given the low values it is clear that the subject's resting HR had been recorded during that time. The peaks seen at time 25 and 35 minutes coincided with the subject evacuating from the muster point to the life craft, and then returning from the life craft to the muster station.

The sections of heart rate analysed (see Table 13) were:

- Heart rate average for 1 minute steady state on commencement of TEMPSC brief.
- Heart rate average during first TEMPSC abandonment, from the siren sounding to the individual returning to the muster point.
- Heart rate average for 1 minute steady state immediately post first TEMPSC abandonment.
- Average heart rate whilst at sea, from the craft leaving the davits to the individual exiting the life craft.

The mean values in Figures 37a & 37b were obviously lower than the HRs elicited by the other 3 training activities. The before values were clustered around the resting HR means, as seen in Figure 27. According to the t-tests of paired differences, the HRs during the TEMPSC abandonment exercise itself increased significantly from the before values †. HRs were shown to have returned to the baseline following the exercise, as no significant difference was found between the before and after values. Generally, the HRs during the TEMPSC abandonment were low relative to what might occur in everyday activities such as walking up stairs.

<table>
<thead>
<tr>
<th>Stage of activity</th>
<th>Refresher HR (bpm)</th>
<th>Combined HR (bpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Stan. devn.</td>
</tr>
<tr>
<td>TEMPSC exercise:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before</td>
<td>80</td>
<td>14</td>
</tr>
<tr>
<td>During</td>
<td>95</td>
<td>13</td>
</tr>
<tr>
<td>After</td>
<td>80</td>
<td>16</td>
</tr>
<tr>
<td>TEMPSC at sea training</td>
<td>84</td>
<td>13</td>
</tr>
</tbody>
</table>

p-value <0.1 †; <0.05 *; <0.01 **; <0.001 ‡
Heart rate trace from a refresher course subject during the abandonment to TEMPSC exercise

The TEMPSC abandonment brief, which finished at time 21 minutes, was delivered with subjects seated. This subject's heart rate increased following the sounding of the evacuation siren at time 24 minutes. Subjects then proceeded from the muster point to the TEMPSC, after donning a lifejacket. The peaks seen at time 35 minutes coincided with the subject returning from the life craft to the muster station. (The peak seen at time 29 minutes coincided with the TEMPSC being launched from the davits, and thus probably represents an artefact resulting from interference with the Sports Tester.)
Figure 37a
Combined subjects' heart rate means during the TEMPSC abandonment

Figure 37b
Refresher subjects' heart rate means during the TEMPSC abandonment
4.2 DISCUSSION OF HEART RATE RESULTS

Despite the variations in training program, very similar heart rates (HR) were reached by refresher and combined subjects. This applied to both the whole groups means as seen in Tables 10 to 13, and to the mean individual paired differences in Figures 29a & 29b. These similarities may well have been expected, and suggest that the physical nature of these exercises was the predominant influence on heart rates.

There were also no obvious differences among the different age groups. Heart rates elicited at a given workload have been shown not to vary with age (Astrand & Rodahl, 1986). No age related HR difference would therefore be expected when considering purely physical effects. The recordings of resting HR agreed with the generally accepted view that normal resting HRs vary between 60 and 80 bpm.

The instances where differences between the combined and refresher subjects' overall HRs did arise were immediately prior to the HUET and the abandonment to life raft exercises. The pre-event HRs may have been elevated more in the combined subjects because they felt relatively more anxious. This possibility was supported by the fact that the combined subjects' mean HR was also higher than the refresher's during the classroom HUET brief. As the brief was essentially the same for both courses, and subjects were seated throughout, it would seem that the higher combined subjects' mean HR resulted from some greater psychological activation. This relatively greater activation could have been anxiety. Indeed, Figure 26 demonstrated that the largest difference in state anxiety scores between the refresher and combineds occurred before the HUET. During the refresher course, the abandonment followed immediately after the HUET exercises, a pre-abandonment anxiety score was therefore not taken for refresher subjects. Thus no comparison could be made between the pre-abandonment state anxiety scores.

The phenomenon of the heart beating at a rate above that predicted from the oxygen consumption at the time is known as "additional heart rate" (Strømme et al, 1978). As no direct measurements of oxygen consumption were made during the offshore training, nor during the exercise test, the physical and psychological effects on HR could not be separated. Distinction between physical and psychological factors, however, "is not easily established" (Rompelman et al, 1980). Future work could involve assessing oxygen consumption as well as HR. Another approach could be to take electromyographic measures from subjects' muscles. This technique has been used to provide an indicator of the contribution of physical activity to any increases in HR.
Heart rates during the activities can be compared to those reached by a group of naval divers during simulated offshore conditions, that is at an average temperature of -2.5°C and wind velocity of 2.8 m/sec (Vaernes et al, 1988). These subjects conducted 2 minutes each of a hand tool task, finger dexterity, heavy muscular work and mental arithmetic, followed by 10 minutes of immobility. This sequence was repeated 8 times. After 80 minutes, HR had increased from 91bpm to 119bpm. The subjects were young, average 23.8 years, divers from the Norwegian Navy, and therefore most probably fitter than the subjects in the offshore training study. The mean HRs during the HUET exercises were 116bpm for refreshers and 119bpm for combined subjects. This suggests that HRs of subjects conducting manual work offshore would at least equal and, given offshore workers' lower fitness levels, probably exceed those reached during the HUET.

The HRs described in a study designed to investigate cardiac responses to thermal stress were slightly higher than those found during any of the offshore training exercises (Taggart et al, 1972). In Taggart et al's study, subjects were assessed following a 10 minute sauna bath. Normal subjects, ranging in age from 21 to 54 years old, showed increases in HR from resting levels of 78bpm to 145bpm after the sauna. It would thus appear that having a sauna resulted in increases in HR slightly above those recorded during the offshore training exercises. It should be noted, however, that the changes in the pattern of the HR, that is the electrocardiogram (ECG), may be different in response to these situations. Preliminary investigations of offshore training have been conducted using ambulatory ECG recorders (unpublished). More extensive investigations using such devices would be worthwhile, to determine whether ECG anomalies arise during the training.

Overall, the HRs elicited during the 4 training exercises followed a similar pattern to that of the state anxiety scores. Most activation, in the form of high levels of HR, large changes from baseline, and slower returns to baseline following completion of the exercise, was observed in the recordings of the fire and HUET exercises. The slow return to baseline may have been a result of the restrictions of this applied situation. This meant that true post resting HR values could not be obtained after the HUET and fire training. Large changes in HR were seen within the abandonment to life raft recordings, but HRs virtually returned to the baseline on completion of the exercise. It was concluded that the abandonment to TEMPSC was not very demanding, as pre-event HR values were equivalent to resting HRs, the values during the TEMPSC abandonment were not especially high, and HR returned to baseline shortly after completion of the abandonment.

Correlations were not carried out on heart rates among the four exercises because of the differences in recording intervals.
4.3 ANALYSIS OF THE PHYSIOLOGICAL REACTIONS - CORTISOL

Samples of urine and saliva were collected at various points throughout the training course, as described in 2.2.2. These were analysed, using radioimmunoassay, to determine the level of free cortisol. Urinary free cortisol was taken as a ratio of creatinine, to provide a measure that was independent of flow rate. Analyses of some samples proved to be impossible due to staining and/or viscosity of the saliva.

The data were thus of two types, salivary free cortisol (SC) and early morning, single sample urinary free cortisol (UFC). Although some individual subjects had values of SC or UFC that were statistically significantly different from other subjects, none of these values were improbable in terms of human physiology, and so no values of SC or UFC were excluded as statistical outliers from the analysis. Initially, dot plots were made of the SC and UFC data by the day of the course on which they were collected (Day), and then by the training activity conducted on that day (Event). As SC had been measured before and after each exercise, paired differences were also plotted for this parameter.

Whole group means and standard deviations were calculated. Means and standard deviations were also calculated with the data split in several different ways, by:

- Day
- Event
- Event and simultaneously the order in which activities were conducted (Order)
- Day and simultaneously by Event.

These values were plotted to show means plus and minus one standard deviation.

The general linear model (GLM) approach to analysis of variance (ANOVA) was applied using Minitab (v8.0 ext), in a manner similar to that used on the anxiety scores. This involved assessing the following factors for their ability to affect the level of urinary cortisol:

- Whether particular training activities had significant effects was assessed using the activity that subjects were undertaking on the day that the sample was collected, referred to as 'event', and the previous day's activity, referred to as 'previous event'.
- The day that samples were collected was included to determine if there were changes over the duration of the course.
- Each subject's age was considered as a possible influencing factor. The term 'age' was also ran as a covariate.
- Comparisons were also made as to whether or not subjects smoked, 'smoke', and according to self-rated fitness, 'fit', and swimming ability, 'swim'.
More complex statistics were then conducted, again applying the GLM approach to ANOVA to the UFC data. A three stage procedure was undertaken to prevent any of the effects of the previous day "carrying over" and masking other significant factors. This involved starting with single morning analyses, to determine a value for the "carry-over" coefficient. The 'previous day's' urinary cortisol level was then multiplied by this coefficient. This was essentially the "carry-over" of the previous day, and was therefore subtracted from the 'present day' urinary cortisol level. GLM was then conducted on the whole set of data with the carry-over effect removed. This process was carried out for both combined, five day course, subjects and refresher, three day course, subjects.

ANOVA is based on the assumption that the data follow a normal distribution. As the cortisol data in this study were found to be skewed from normal, it was put through a transformation. Logarithmic transformation was used as the underlying model on which the cortisol analysis was based was expected to contain exponential components (Bolton, 1984). Normality was later checked in SPSS using Q-Q plots, and in Minitab by plotting histograms of residuals. The above process of accounting for carry-over followed by GLM was then repeated.

The following procedure was then applied to extract both the carry-over and possible subject effects. Firstly, each subject's average UFC level over the duration of the course was calculated. This value was subtracted from each of that subject's individual recordings. The above GLM analyses were then conducted using logarithmic data.

Multiple analysis of variance (MANOVA), was conducted to determine if there were any correlations among the measures taken simultaneously at enrolment, these were UFC, SC, and state anxiety (STAI). MANOVA was applied to the data that were collected early on each morning of the course. These were the UFC and STAI scores.

Calculations were made to assess whether particular orders of carrying out activities, and particular days had significant effects on the UFC levels. A Repeated Measures technique using MANOVA was applied (Hand & Taylor, 1987), with the aid of SPSS for Windows statistical software (v6.0). Such analyses, using this particular software, require complete data sets for each subject. There were 45 (out of 52) subjects on the refresher course, and 35 (out of 47) subjects on the combined course with complete UFC data sets. On the combined course the fire training was spread over two days. As UFC was assessed on the morning of each day the effects of fire training on day 1 were considered along with those on day 2. Natural logarithms were used to normalise the data. An iterative method determined the size of the carry-over effect and the data were adjusted so that the carry-over effect was removed. As there were only 13
subjects with complete SC data sets the Repeated Measures technique was not applied to the SC data.

Whether a factor was significant or not, and how significant depended upon the p-value that was determined from the statistical analyses. The following groupings of p-values are referred to in the results with their respective symbols, p less than: 0.1 †, 0.05 *, 0.01 **, or 0.001 ‡. These values represent increasing levels of significance.

4.3.1 Results of urinary cortisol analyses

Figures 38a & 38b show a first morning high followed by a drop in the level of UFC. This pattern of daily UFC was seen in both the combined and refresher subjects' data. The UFCs then reached a plateau. This is clearer in the combined group as samples were collected over 5 days rather than just 3. The variation seen amongst subjects for individual mornings was large, but this is normal for UFC recordings.

![Graphs showing urinary cortisol levels](image)

**Figure 38a**
Combined subjects' daily urinary ratios of cortisol to creatinine - means ± SD

**Figure 38b**
Refresher subjects' daily urinary ratios of cortisol to creatinine - means ± SD

UFC values, when considered all together, had an overall significant carry over effect from one day to the next for combined subjects ‡. The significant carry-over implied that the level of cortisol activation was elevated partially due to the effects of the previous day.

p-value <0.10 †; <0.05 *; < 0.01 **; <0.001 ‡.
With the carry-over effect removed, neither the event nor the day of the course that the sample was collected, were found to have significant effects on the combined subjects' urinary cortisol level. The day of the course was, however, close to being significant when the data were analysed in logarithmic form. (Note the data were log transformed because, as is frequently found with biological data, the UFC values were skewed from normal. Log transformation normalises the data therefore fulfilling the requirements for ANOVA.) With the effect of inter-subject variation extracted, the same pattern was observed, except that the day effect was more significant **.

The UFC data from the refresher subjects were converted using logarithms (log UFC). GLM analysis showed that the average on enrolment was highest, then the average on day 3, and the average on day 2 was lowest. The log UFC data from day 3 was found to have a significant rank correlation with the log UFC data on day 2 **. The presence of a carry-over effect for the refresher subjects UFC data was thus indicated. UFC values from the day of enrolment were not included in the Repeated Measures or GLM analysis below. This was because no pre-course UFC value was available, therefore an enrolment value adjusted for carry-over could not be calculated. Furthermore, subjects were not informed beforehand which exercise would take place on the day of enrolment. It might thus be expected that the exercise on day 1 would not have any effect on UFC values.

Repeated Measures analysis was applied to determine the overall change in daily cortisol for subjects with complete data sets. The subjects were divided into five 'order-groups'. These were defined according to the order that the subjects in the group had carried out the HUET/abandonment, fire and TEMPSC exercises (see Table 3). Note that the exercise carried out by a subject on a particular day can be identified from the 'order-group' to which the subject belonged. The Repeated Measures analysis was carried out iteratively on the data from days 2 and 3, adjusted for carry-over from the previous day, until the correct amount of carry-over was determined. The results of this analysis showed that there was no significant difference among the five groups of subjects, but that there was a significant difference between days** and among the 'order-groups' on particular days*. As the order-group on a particular day defines the exercise on that day, it was possible to compare the different exercises from the Repeated Measures results. It was found that the TEMPSC exercise appeared to cause higher log UFC values than the fire or HUET/abandonment exercises. The GLM analysis of the log UFC data from days 2 and 3, adjusted for carry-over from the previous day, also provided adjusted means for the exercises. These adjusted means were highest for the TEMPSC, then HUET/abandonment, and lowest for the fire exercise. These seemed the opposite to expected, and may have been due to the large number of subjects who practised the TEMPSC exercise.
on day 1 (see Table 14), when the other factors indicated that anxiety levels were high. The balance of events on days 2 & 3 were therefore distorted. Ideally, each of the 3 events would be undertaken by an equal number of subjects on each of the days. Furthermore, one order group, who had completed the TEMPSC training on day 2, had a totally different pattern from the remaining groups. One subject in particular from this group had an especially high day 2 UFC value. This affected the event mean values.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Number of subjects on:</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Day 1</td>
<td>Day 2</td>
<td>Day 3</td>
</tr>
<tr>
<td>HUEt/Abandonment</td>
<td>8</td>
<td>25</td>
<td>19</td>
</tr>
<tr>
<td>Fire</td>
<td>7</td>
<td>23</td>
<td>22</td>
</tr>
<tr>
<td>TEMPSC</td>
<td>37</td>
<td>4</td>
<td>11</td>
</tr>
</tbody>
</table>

Repeated Measures analyses of the overall change in daily cortisol in the subjects with complete datasets, was then conducted to determine how the UFC changed from one day to the next. Enrolment UFC values were significantly higher than day 2 values for both combined subjects ‡ and refresher subjects *. For combined subjects the UFC values rose slightly and then remained stable on days 3, 4 and 5. Overall there was a pattern of initial highly elevated UFC values, followed by a drop, and then a slight elevation to a plateau. The drop on day 2 to below the course baseline, could possibly be interpreted as a result of the cortisol axis recovering from the hyper-activation of the previous day.

The combined subjects' data were divided into groups according to the event conducted on the day of collection, and the order that the training was carried out. The only significant effect found when the data were plotted, and analysed using Repeated Measures was an order by event interaction effect ‡. The interaction of order with event was equivalent to the effect of day. Individual differences were detected, but these were predominantly when an event had occurred on the first day of training. These most probably were a result of general course anxiety, rather than related to the particular event. This seems especially likely as subjects did not know which event they would be completing on the first day. Event assessed as a factor by itself was not very significant.

Although event was not found to be very significant for combined subjects, this could have been the result of the compounding effect of day and event. This can be seen in Table 15, The distribution was such that one particular event predominately occurred on one particular day. The
event effects could therefore have been masked by the day effects. As the events were conducted by other subjects on the other days of the week, however, event and day were not entirely coincident. To be able to assess the effect of event without the influence of day effects, all the events would have to be conducted by all the subjects in one day.

Table 15

Distribution of combined subjects completing particular events over the days of the course

<table>
<thead>
<tr>
<th>Activity</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
<th>Day 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>HUET</td>
<td>21</td>
<td>11</td>
<td>11</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Abandon</td>
<td>4</td>
<td>28</td>
<td>7</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Fire day 1</td>
<td>7</td>
<td>1</td>
<td>25</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>Fire day 2</td>
<td>0</td>
<td>7</td>
<td>1</td>
<td>25</td>
<td>14</td>
</tr>
<tr>
<td>TEMPS C</td>
<td>15</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>29</td>
</tr>
</tbody>
</table>

As each event was completed only once by each subject, it was not possible to conduct a Repeated Measures analysis with event as the repeating factor. As the interaction of each order with each day corresponds to a particular event, however, it was possible to extract a measure of the effect of each event. The event effect values were extracted from the outcome of the Repeated Measures analysis on the combined subjects' log UFC data. It was found that UFC was highest on the second day of the fire training and lowest on the day of the TEMPS C training for combined subjects. The ranking of the other events can be seen in Figure 39. Given the unbalanced distribution of the events over the days of the course, it was difficult to calculate whether there were significant differences among the events. Day 2 of the fire training did, however, appear very much higher than the others. This suggested that, in terms of concern regarding the next event, the combined subjects were most concerned about the 2nd day of fire training.
Figure 39
Event effects on combined subjects' log UFC values
The effects of event, taken from Repeated Measures analyses on
combined subjects logged UFC, and therefore adjusted for day and order.

GLM analysis on combined subjects' data found that age, self-rated
swimming ability, and whether subjects smoked, did not affect the level of
cortisol in the urine samples collected at enrolment. Subjects self-rated
level of fitness was significant at a low level †. For refresher subjects no
significant effects were found on UFC values at enrolment for any of these
factors, age, self-rated swimming ability, whether subjects smoked, nor
self-rated fitness level.

MANOVA resulted in similar conclusions to the above. The main
exception was that for refresher subjects, those who smoked were found to
have higher UFC levels at enrolment * than those who did not smoke.
This anomaly between the outcome of the two types of analyses probably
results from the requirement for complete data sets for MANOVA. Only
33 refresher subjects' data were therefore analysed in the MANOVA, as
opposed to 49 in the GLM analyses. When all of the morning UFC values
were analysed, smoking was not found to be a significant factor.

The main findings of the analyses of the urinary free cortisol ratios can be
summarised as:

- There was an initial peak in UFC values on the first morning of the
course. This was followed by a drop after which UFC values remained
relatively constant.
- The UFC value of the previous day had significant carry-over effects
to the current day.
• The event conducted on the day that the sample was collected did not have significant effects on combined subject's UFC levels. When carry-over was accounted for and the data were converted into logarithmic form, significant event effects were found in the refresher subjects' UFC data.

• The refresher subjects' UFC values were highest on the day of the TEMPSC training. This was probably because most of the TEMPSC training was conducted on the first day, and therefore coincided with the first day peak. For combined subjects, UFC collected on the second day of fire training appeared to be higher than those collected on the other days.

• The day on which the sample was collected was significant for refresher and combined subjects' UFC.

• UFC at enrolment only was found to be higher in refresher subjects who smoked compared to non-smokers.

4.3.2 Results of salivary cortisol analyses

The values of salivary cortisol at enrolment, when subjects were not involved in any particular task, stand out as relatively high when compared to the values obtained after the 4 chosen events, see Figures 40a & 40b. This was the case for both combined subjects, and refresher subjects, although the latter had previously attended survival training. The elevation of the enrolment SC reflects the high urinary cortisol values found at enrolment, see Figures 38a & 38b. The profile plots of salivary cortisol also demonstrated that, rather than having a normal distribution, the data were skewed.

Most activities were found to result in an increase in the salivary cortisol median. The combined subjects appeared to have decreased salivary cortisol following the selected TEMPSC training exercise. Little change was seen following the exercise test nor the TEMPSC training for refresher subjects.
Figure 40a

Profile of combined subjects' salivary cortisol data

Combined subjects' pre and post activity salivary cortisol data. Median, upper and lower quartiles, as well as minimum and maximum adjacent values were plotted. The + are possible outliers, the O are probable outliers. The activities included the helicopter underwater escape training, HUET; the abandonment to a liferaft, abandon; the self-rescue from a smoke filled room, fire; the abandonment to a liferaft, TEMPSC; and the exercise test, ex-test. One subject was found to have unusually high values before and after the exercise test, 80.0 & 82.0 nmol/L respectively. These values were not included in the above plot.

Figure 40b

Profile of refresher subjects' salivary cortisol data

Refresher subjects' pre & post activity salivary cortisol. Median, upper and lower quartiles, as well as minimum and maximum adjacent values were plotted. The + are possible outliers, the O are probable outliers. No pre abandonment saliva samples were collected, see section 2.2.2. The activities included the helicopter underwater escape training, HUET; the abandonment to a liferaft, abandon; the self-rescue from a smoke filled room, fire; the abandonment to a liferaft, TEMPSC; and the exercise test, ex-test.
Salivary cortisol was then assessed in terms of the difference between the pre and post activity values. The differences are plotted in Figures 41a & 41b. (Unlike the absolute values, the profile of the differences did not indicate that the data were skewed.) One sample t-tests of the differences demonstrated that, for combined subjects, both the HUET * and abandonment * post values had increased significantly from the pre activity values. The cortisol did not change significantly after the fire training nor the TEMPSC exercises.

![Graph showing cortisol levels for different activities](image)

**Figure 41a**

Combined subjects' means ± SD of the paired differences of post minus pre activity salivary cortisol values.

Unlike the combined subjects, the refresher subjects' salivary cortisol increased significantly after the fire training exercise *. Ursin and Olff (1993) have said that cortisol levels increase, in response to a stressor, 10 minutes after the onset of the stressor. Although, the refresher fire training exercise was approximately 2 minutes longer than the combined, it therefore seems doubtful that this was the reason a significant difference was only detected in the refresher group.

No change was detected after the TEMPSC exercises. Similarly, no change was detected after the refresher subjects' HUET exercises. This could have been due to the short time scale of the exercise in the refresher course, 11 minutes, compared to the combined course, 32 minutes. Samples collected after the refresher exercise may not have entirely
encompassed a cortisol peak. As the HUET was followed immediately by the abandonment exercises, see section 2.2.2, no pre-abandonment saliva samples were collected. The cumulated effect of HUET and abandonment exercises was assessed by analysing the difference between the pre-HUET and post-abandonment cortisol values. Following this, a significant increase was detected *.

![Graph showing cortisol levels](image)

**Figure 41b**
Refresher subjects' means ± SD of the paired differences of post minus pre activity salivary cortisol values

Multiple analysis of variance was conducted on the enrolment values only. This showed that, for combined subjects, age was close to significance at the 10 % level, \( p=0.106 \). As the coefficient was negative, this indicated that older combined subjects were inclined towards lower enrolment salivary cortisol values. Age did not have a significant effect on refresher subjects. Refresers who smoked were, however, found to have higher salivary cortisol values at enrolment than non-smokers **.

The main findings of the salivary cortisol analyses can be summarised as:

- SC values were relatively high at enrolment.
- SC generally increased from pre to post activity, except for the exercise test and the TEMPSC abandonment.
• Significant increases were found following the HUET and abandonment to life raft exercises in the combined subjects. For the refresher subjects significant increases were found following the fire training and when the HUET and abandonment (completed in one session during the refresher course) were considered together.

• SC was higher at enrolment in refresher subjects who smoked compared to non-smokers.

• Older combined subjects were found to have lower SC values at enrolment, though the significance level of this was low.

4.3.3 Correlation of cortisol levels with anxiety

Despite the finding that all factors were relatively high, no overall correlations were found among the first morning, or enrolment, urinary cortisol, salivary cortisol, and state anxiety inventory scores. Nor were any significant relationships found between any of the 3 measures and the event conducted on the first day. The latter would not be expected, given that subjects did not know which activity, or event, they would be presented with on the first day.

A comparison of Figures 42a & 42b with Figures 38a & 38b showed that the mean morning STAI values appeared to follow a similar pattern to the morning UFC values. Mean log UFC values, taken from the results of GLM analysis and therefore adjusted for event and subject, were compared with mean STAI values. This indicated that a difference existed between the UFC and STAI patterns on day 2. The adjusted UFC value for day 2 was lower than those for days 3, 4 & 5. The mean STAI score for day 2, however, appeared higher than days 3 & 5, and little different from day 4. Thus, unlike UFC, no dip in the STAI scores was detected on day 2, relative to the remaining days.

For the refresher results, this pattern was not discernible as the course only lasted 3 days.
Aside from day 2, the patterns of day to day change were similar for UFC values and morning STAI recordings. Like the UFC values, enrolment STAI scores were found to be significantly higher than those on day 2 for refresher ¤ and combined subjects ‡. The STAI scores on day 3 then fell below the average of day 1 & 2 for refresher ** and combined * subjects. The level of state anxiety, like the UFC, then remained stable over the rest of the course for the combined subjects.

Repeated Measures analysis was conducted in the same manner as on the log UFC data. No significant difference was found in STAI scores among the different order-groups. The values of the combined subjects' event effects on STAI, which had the effects of day and order accounted for, were extracted. The trends were found to be similar to those of the UFC data (see Figure 39). Like the UFC values, the STAI effect values associated with the 2nd day of fire training were the highest, and the TEMPSC were the lowest. Slight differences from the pattern of UFC values were, however, found. The STAI effect values associated with the abandonment were higher than for the UFC, and the 1st day of fire training were lower than the UFC.

p-value <0.10 ‡; <0.05 *: <0.01 **; <0.001 †.
Given the overall apparent similarities, the lack of statistically significant correlations could be a result of the size of the sample. Once the data were split into the event conducted on the day of collection, group sizes were fairly small, hence correlation coefficients had to be high in order to be deemed significant. There were some correlations that were close to significance, which suggests that larger subject numbers could have resulted in significant relationships. Further support for links between cortisol and STAI was found in the salivary cortisol data. The outliers seen in the plots of salivary cortisol, when singled out, were found to have relatively high scores on the pre-event STAI. This was found especially in the combined subjects group.

4.4 DISCUSSION OF CORTISOL RESULTS

Initial high peaks in early morning urinary free cortisol (UFC) were detected, similar to the high level of state anxiety inventory scores (STAI) measured on day 1. As the peaks were found in the recordings taken when subjects had just enrolled on the course, and therefore not carried out any training activities, it seemed likely that most of the peaks were a result of pre-course anxieties. It was proposed that some degree of pre-course anxiety might be expected prior to attendance of any course. This theory was supported by the fact that individuals with previous training experience, refresher subjects, as well as those new to the course, combined subjects, demonstrated an initial peak. Furthermore, both combined and refresher subjects demonstrated high salivary cortisol (SC) levels at enrolment, relative to the values obtained after the 4 chosen events. Cortisol release, however, follows a circadian pattern. Cortisol thus generally reaches its zenith in the hours around the time of waking in the morning, then drops during the day (Weitzman et al, 1971). As the enrolment samples were collected early in the morning, and the pre-event samples were associated with events that took place later in the day, the former would be expected to be relatively high.

Kirschbaum and Hellhammer (1989) conducted a large scale study on 662 healthy adults and found early morning SC values of 14.3±9.1nmol/L. In comparison, the mean enrolment SC values from this study were not especially high, values were 10.0±5.7nmol/L for combined and 11.0±6.9nmol/L for refresher subjects. Full details were not given of Kirschbaum and Hellhammer's sampling and analysis protocol, however, hence differences could have arisen due to, for example, the use of different assay techniques. Conversely, on considering urinary levels of cortisol, 33.9±22.8 and 32.3±19.0μmolcortisol/molcreatinine for combined and refresher subjects respectively, values did appear high when compared to the ceiling limit of 25μmolcortisol/molcreatinine used by the Department of Clinical Biochemistry at Aberdeen Medical School (unpublished data from 200 routine checks on patients referred by GPs). This difference between relative salivary and urinary levels could have
resulted from the fact that there is a delay in cortisol entering the urine (Fillenz, 1993). UFC therefore reflects chronic activation of the hypothalamic-pituitary-adrenal (HPA) axis. UFC data would thus have encompassed the activation resulting from anxiety felt over the previous day. Alternately, SC has been shown to provide a virtually instantaneous correlate of the level of plasma free cortisol (Umeda et al., 1981), and having a half-life, an indicator of the rate of disappearance, of approximately 60 minutes (Kirschbaum & Hellhammer, 1989) is thus an acute measure.

Overall, the results suggest that as UFC levels were elevated at enrolment, individuals were experiencing some concern before coming on the course. The enrolment SC means were low, relative to Kirschbaum and Hellhammer's data, but still comparable with the higher of the post-event SC recordings. Subjects were thus showing physiological signs of concern at the time of enrolment. The latter was corroborated by the finding that STAI, or state anxiety levels, were higher on the day of enrolment than on the following mornings of the course.

A significant carry-over effect was found in the daily UFC recordings, that is, UFC levels were affected by the level of UFC on the previous day. UFC, as discussed above, is a chronic measure of the level of cortisol production and therefore provides some indication of the level of activation of the hypothalamic-pituitary-adrenal axis. It might therefore have been expected that the previous day's UFC, or indirectly level of hypothalamic-pituitary-adrenal axis activation, would affect the UFC of the current day. Whether this carry-over effect is present in every-day life does not appear to have been investigated and reported in the literature. This could have been the result of some form of psychological effect, opposite to anticipation, that meant the previous day's experiences were affecting the level of cortisol axis activation. Subjects did not appear to demonstrate a chronic coping inability, however, as the level of cortisol was seen to fall from the start to a plateau, rather than accumulating over the week. Also, the majority of subjects showed a fall in STAI after the first morning, suggesting that they returned to a 'baseline' level of state anxiety.

An anomaly in the pattern of change of STAI and UFC was, however, found on day 2. UFC recordings demonstrated a dip relative to days 3, 4 & 5, whereas early morning STAI did not. It was suggested that this was a result of the hyperactivation of the first day exhausting the HPA axis, and thereby reducing its excretory capacity on day 2. Given the above, and the absence of a dip on day 2 for STAI recordings, it could be proposed that the state anxiety inventory gave a more accurate instantaneous indication of how subjects were feeling first thing in the morning than single urinary cortisol samples. As UFC is a chronic rather than an acute measure, this might have been expected.
Refresher subjects who smoked were found to have higher levels of cortisol in both urine and saliva, relative to non-smokers, but only at enrolment. This could have been a chance effect or a result of subjects being especially anxious at enrolment and therefore smoking more than on the remaining mornings of the course. (Anxiety levels were higher at enrolment in refresher subjects who smoked, compared to non-smokers.) A direct smoking effect might be expected with cortisol readings, as nicotine is generally believed to "induce an increase in total plasma cortisol levels" (Kirschbaum & Hellhammer, 1989). Indeed a recent study by Strasburger and Kirschbaum (1994) indicated that "acute nicotine exposure in habitual smokers" stimulated the release of various hormones, including cortisol. In contrast, they found that the smokers' SC responses to a psycho-social task were diminished, relative to a comparable group of non-smokers. As subjects generally did not have the opportunity to smoke before the practical training activities, the latter finding might explain why no overall smoking effect was detected.

For refresher and combined subjects, the pre and post event SC values indicated that the abandonment exercise appeared to be associated with the highest levels of response. This was probably a result of the physical nature of the abandonment to life raft exercise. Significant changes were seen following the HUET and abandonment exercises for the combined subjects' data, and following the fire training for the refresher subjects' data. Differences may not have been detected for the combined fire training exercise and the refresher HUET exercises due to the short time scale of these exercises. Furthermore, the smokehouse used for the refresher training was more complex, and therefore more demanding both physically and mentally. The change in cortisol during the fire training exercise could thus have been more intense in the refresher subjects, resulting in a significant change from pre to post. Ursin & Off (1993) have stated that cortisol generally starts to increase, in response to a stressor, 10 minutes after the onset of the stressor. Samples collected within that time may therefore not have encompassed a cortisol peak. This agrees with Hubert & de Jong-Meyer (1989) who found that following a psychological stimuli cortisol peaked after 20 to 30 minutes. The time from stimulation to peak cortisol response does, however, vary depending on the intensity of the stimuli and "(probably) the nature of the situation" (Kirschbaum & Hellhammer, 1989). Future studies involving series of saliva samples, possibly taken every 20 minutes, would provide more detail as to the overall pattern of cortisol change.

The pre-HUET mean SC values were compared to those from Hytten et al's study (1989), which included similar measurements on 70 HUET trainees at the NUTEC training centre in Bergen. They found pre-event salivary cortisol values of 13.6 ± 8.5 nmol/L, therefore, somewhat higher than the values of 5.9 ± 4.9 nmol/L for 37 combined subjects and 6.8 ± 3.8 nmol/L for 39 refresher subjects in this study. Unfortunately,
comparisons among different studies can be misleading, primarily because of the anomalies that can arise purely as a result of the use of different biochemical analytical techniques.

The general impression from the SC results was that demands on the individual sufficient to lead to significant short term increases in SC only occurred during the HUET and abandonment exercises for the combined subjects, and the fire training for the refresher subjects. Furthermore, the significant changes that did occur were not very much larger than the changes in SC seen as a result of the exercise test. This suggests that the training exercises were not especially demanding, as assessed by changes in SC, especially when compared to the outcome of an exercise test that most subjects did not perceive as difficult. Had further samples been collected after the training exercises, later peaks, or further increases, may have been detected. It seems probable, however, that later samples would not have resulted in a significantly different outcome than was observed. This can be surmised from the finding that the difference between refresher subjects' pre-HUET and post abandonment samples, which were therefore approximately 40 minutes apart and included the cumulative effects of the HUET and abandonment exercises, was not significantly greater than that between the pre and post HUET samples in the combined subject group.
5.0 CONCLUSIONS AND RECOMMENDATIONS

The results of all the parameters used in this study indicated that attention should be directed toward reducing pre-course apprehensions. This was concluded since early morning anxiety and urinary cortisol data showed initial peaks at enrolment then both dropped to a plateau over the remainder of the course. Furthermore, when all of the anxiety scores, both early morning and pre-event, were considered in chronological order, a relative decrease in anxiety over the duration of the course was found.

The salivary cortisol data, representing acute measures of stress, was found to have the highest absolute values during the abandonment to life raft exercise. The general impression, however, was that demands on the individual sufficient to lead to significant short-term increases in salivary cortisol only occurred during the HUET and abandonment exercises for the combined subjects, and the fire training for the refresher subjects. As the changes that did occur were not very much larger than the changes seen as a result of a modest exercise test, it would seem that the training exercises were not especially demanding. To gain a full picture of changes in salivary cortisol, however, future work would have to incorporate series of saliva samples, for example collected every 20 minutes.

Analysis of the state trait anxiety scores (STAI) revealed that:

- For the refresher group overall, the older the subject, the lower the anxiety scores were. The lack of a significant age effect in the combined subject group indicated that the refresher age effect was a result of older individuals having had more experience of survival training, and possibly offshore life, which includes practising emergency drills. That anxiety was found to decrease as a result of extra training experience suggested that repetition of survival training was beneficial. It was also determined, however, that older individuals found the training to be more demanding than they had expected. This, along with the physically demanding nature of some of the training, indicated that particular consideration of the needs of the oldest trainees would be worthwhile.

- Subjects who smoked generally experienced more anxiety and less positive coping benefits than non-smokers.

- Non-swimmers were more anxious than subjects who could swim. Increasing the availability and emphasising the utility of water confidence classes could therefore aid in reducing the additional anxieties experienced by non-swimmers.

Among the anxiety scores the pre-HUET and pre-abandonment to life raft values were the highest. On comparison with other training situations,
however, the values were not especially high. Yet, lower anxiety was associated with greater perceived ability of coping with the course and with possible future incidents. This negative relationship between anxiety and perceived coping emphasised the need to minimise the extent of anxiety experienced during the course, in order to maximise the benefits to trainees. Future work including external assessments of performance would allow correlations among actual performance, anxiety and perceived abilities to be determined.

The suggestion that experience of the training reduced feelings of anxiety was supported by the finding that heart rates were relatively higher in the combined subjects than the refresher subjects. During the HUET brief, when subjects were seated at rest, heart rates were reached that were above those that might have been expected from the energy requirement of the individual. The 'additional heart rate' was possibly a result of psychological activation, most probably in the form of anxiety. Future studies could aim to separate the extent of changes in heart rate occurring as a result of physical demands from those that are above physiological requirements, therefore presumably a result of psychological activation. This could include either measures of oxygen consumption or electromyographic recordings, an indicator of muscle activity, being taken during the training.

The heart rates elicited during the HUET exercises were found to be comparable, if not lower, than those that might be expected during moderate manual external work offshore. Relatively higher heart rates were found during the abandonment to life raft and fire training exercises. These were probably a reflection of the physical nature of these exercises. Overall, the judgements that were made from the heart rate levels reached, changes in heart rate, and time to return to baseline supported the conclusions that were drawn from the STAI results. Studies using ambulatory electrocardiograph (ECG) recorders would have to be conducted in order to determine whether pathological changes, in relation to the heart, occur during training. Ambulatory ECGs record the detailed pattern of the heart beat, therefore enabling irregular changes to be detected and possibly correlated with particular activities.

With regards to course content, several conclusions were drawn from the results of the course evaluation questionnaires. These suggested that:

- A reduction in the extent of smoke contact within the fire training could reduce levels of physiological and psychological activation. Retention of the smoke appreciation exercise within the combined course may still, however, be considered relevant.

- Additional allowance could be made to alleviate the disorientation experienced during the HUET exercises. This seemed especially pertinent as it was found that significant numbers of experienced refresher subjects, as well as combined or novices, rated disorientation
as difficult. Disorientation could be reduced by initially allowing trainees to wear goggles, and providing the option of taking part in additional capsizes.

- The drills associated with the abandonment to life raft exercise were found to be physically demanding. Special consideration should therefore be placed on assessing trainee's physical fitness to take part in the training. (Physical fitness should not necessarily be related to age.) This is linked to the question of defining fitness to work offshore. If individuals are unable to complete the training, then presumably they will be less able to cope with an emergency offshore. In which case the possible risks both to themselves and others should be considered carefully.

- The TEMPS training was not found to be associated with any particular difficulties. It was, however, felt by some subjects that the balance of time allocated to the large amount of information given regarding davits, etc. and that for the boat handling at sea could have been altered.

- Both combined and refresher subjects felt that they had coped well with the training. Individuals also felt, though to a slightly lesser extent in the refresher group, that the training had improved their ability to cope with future offshore emergencies.

Pre-course apprehensions might be alleviated by providing trainees with additional information before enrolling on the course. This could take the form of a brief information leaflet outlining the course contents, or a short video of the main training areas, possibly with frank comments from previous trainees. Anxiety resulting from uncertainty over what may be involved in the course and what will be required of the trainee could therefore be reduced.

Methods of reducing anxiety particularly associated with the HUET exercises could include highlighting the aspects of helicopter safety during the HUET brief and possibly steering the emphasis away from the HUET itself. The reason for conducting the training is after all to increase familiarity and confidence in helicopter transport and the recommended actions during a ditching, rather than with the HUET.

Other methods of reducing anxiety might include instruction on stress reduction techniques, and more extensive debriefing following the exercises. The latter could be directed to put the accent on individual's positive experiences of the training and to enhance the system of support within the group. Emphasising the positive aspects should aid in developing positive response-outcome-expectancies, i.e. improving self-perceptions of ability. Group or social support could be beneficial by acting as a "stress buffer". Additionally, confidence building classes could be provided for trainees who were not satisfied with their own performance and felt that they would benefit from additional practice, instruction and/or feedback.
ACKNOWLEDGEMENTS

The authors gratefully acknowledge the following organisations and individuals without whose co-operation and assistance this study could not have been carried out.

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- The Offshore Safety Division of the Health and Safety Executive who provided funding and enabled publication of the work
- British Gas, especially the late Dr Brian Ballantine, who both provided an initial impetus and contributed additional funding
- The trainees who participated in the study
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- Sam Brooke who drafted the original proposal.
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APPENDIX 1 - COURSE CONTENT

COMBINED BASIC OFFSHORE SURVIVAL FIREFIGHTING FIRST AID COURSE

Duration: 5 Days

SURVIVAL

ENROLMENT/MEDICAL SCREENING

COURSE BRIEF to include: a. Course aims and objectives; b. Terminal objectives; c. Course Programme; d. Safety Procedures; e. Facilities available

DRY LIFERAFT DRILL to include: a. Davit launch; b. Conventional launch; c. Construction; d. Liferaft equipment; e. Boarding and righting techniques

WET DRILL (PRACTICAL) to include: a. Entering water from a height; b. Boarding a liferaft; c. Righting an inverted raft; d. Rescue techniques

HELICOPTER SAFETY to include: a. Procedures before flight; b. Embarking; c. Equipment inside the helicopter; d. Disembarkation; e. Emergency landing on land; f. Emergency landing on water

HELICOPTER UNDERWATER ESCAPE (PRACTICAL) to include: a. Ditching on water; b. Surface evacuation into a helirraft; c. Partial submersion; d. Rapid capsize; e. Aviation lifejacket inflation; f. Helicopter winching exercise

SAFETY to include: a. Health and Safety at Work Act 1974; b. Defining an accident; c. Safe systems of work; d. Permit to work; e. Work site safety

FIRST AID to include: a. Principle aims; b. Preservation of life; c. Prevention of worsening; d. Promotion of recovery; e. Identification of treatment; f. Priorities in an emergency

RESUSCITATION (PRACTICAL) to include: a. Expired air resuscitation (EAR); b. Single man rescue; c. Double man rescue; d. External chest compression (ECC); e. Airway; f. Breathing; g. Circulation; h. Recovery position

PHYSIOLOGY to include: a. Immersion; b. Post immersion; c. Initial immersion; d. Short term immersion; e. Long term immersion; f. Effects of hypothermia; g. Rapid recovery; h. Re-warming by immersion
LOCATION AIDS to include: a. Visual location aids; b. Sea cell powered light; c. Waterproof signal torch; d. Heliograph mirror; e. Pyrotechnics; f. Personal location devices and EPIRB; g. Radar transponder; h. Emergency radios

ABANDONMENT EXERCISE (PRACTICAL) to include: a. Survival techniques using survival suits and lifejackets; b. Liferaft inflation; c. Casualty care; d. Water entry from a height

SURVIVAL TECHNIQUES to include: a. Preparation; b. Protection; c. Location; d. Water; e. Food; f. Rescue

TEMPSC INTRODUCTION to include: a. Types of TEMSPC and construction details; b. Capacity, seating arrangement and use of seat belts; c. Self righting capability; d. Inherent buoyancy; e. Function of TEMSPC; f. Engine and helm position controls; g. Primary and secondary method of engine start; h. Deluge system; i. Life support system; j. Fuel system and location of valves.; k. Ancillary equipment; l. Compass; m. Clearing installation and taking up safe position

DAVIT EXERCISE to include: a. Operation of lowering and release mechanism; b. Clearing away and preparation of TEMSPC prior to abandonment; c. Pre-abandonment checks; d. Boarding procedures; e. System of recovery

ABANDONMENT EXERCISE to include: a. TEMSPC muster; b. TEMSPC Preparation; c. Embarkation; d. Lowering and release

SEA EXERCISE to include: a. Steering; b. Recovery of man overboard; c. Streaming and recovery of sea anchor; d. Operation and firing of parachute rocket

TEMPSC THEORY to include: a. Single fall; b. Double fall; c. Use of TEMSPC emergency equipment and supplies.

FIREFIGHTING

ADMINISTRATION/INTRODUCTION to include: a. Course objectives; b. Programme; c. Safety

COMBUSTION THEORY to include: a. Fire spread; b. Methods of Extinction

BREATHING APPARATUS THEORY to include: a. Full duration; b. Short duration; c. Escape types

PROTECTIVE CLOTHING to include: a. Types; b. Issues
BREATHING APPARATUS DONNING AND WALKABOUT to include: a. Donning; b. Walkabout in open air

HOSE AND MONITOR DEMONSTRATION to include: a. Dry hose running; b. Wet hose running; c. Branch handling

HYDROCARBONS AND CYLINDER FIRES to include: a. Liquid hydrocarbon; b. Contained spill; c. Cascade; d. Pressure and Class A fires

EXTINGUISHER (THEORY) to include: a. Current types; b. Water; c. Foam; d. CO2; e. Halon (demonstration)

EXTINGUISHER (PRACTICAL) to include: a. Extinguishing fires with various types of extinguisher

VALVE ISOLATION EXERCISE to include: a. Team working on various fire props isolating a pressure fire

SELF RESCUE to include: a. Practical self rescue exercise in smoke with emphasis on moving correctly and assisting others

PLATFORM HAZARDS to include: a. Risk areas; b. Fire protection areas

GOOD HOUSEKEEPING to include: a. Fire prevention; b. Actions in an emergency

COMBINED OFFSHORE SURVIVAL AND FIREFIGHTING REFRESHER COURSE

Duration: 3 Days

SURVIVAL

ENROLMENT/MEDICAL SCREENING

COURSE BRIEF to include: a. Course aims and objectives; b. Terminal objectives; c. Course programme; d. Safety procedures; e. Facilities available

RESUSCITATION (PRACTICAL) to include: a. Expired air resuscitation (EAR); b. Single man rescue; c. Double man rescue; d. External chest compression (ECC); e. Airway; f. Breathing; g. Circulation; h. Recovery position
LOCATION AIDS to include: a. Visual location aids; b. Sea cell powered light; c. Waterproof signal torch; d. Heliograph mirror; e. Pyrotechnics; f. Personal location devices and EPIRB; g. Radar transponder; h. Emergency radios

RESCUE to include: a. Search and rescue operations and techniques; b. Reception of evacuees and survivors; c. Rescue techniques using surface vessels, aircraft, fixed wing and helicopters

PHYSIOLOGY (physiological aspects of cold water survival): to include: a. Immersion; b. Post immersion; c. Initial immersion; d. Short term immersion; e. Long term immersion; f. Effects of hypothermia; g. Rapid recovery; h. Re-warming by immersion

WET DRILL (PRACTICAL) to include: a. Entering water from a height; b. Boarding a liferaft; c. Righting an inverted raft; d. Rescue techniques

HELICOPTER UNDERWATER ESCAPE (PRACTICAL) to include: a. Ditching on water; b. Surface evacuation into a heliraft; c. Partial submersion; d. Rapid capsize; e. Aviation lifejacket inflation; f. Helicopter winching exercise

ABANDONMENT EXERCISE (PRACTICAL) to include: a. Survival techniques using survival suits and lifejackets; b. Liferaft inflation; c. Casualty care; d. Water entry from a height

TEMPSC INTRODUCTION to include: a. Types of TEMPSC and construction details; b. Capacity, seating arrangement and use of seat belts; c. Self righting capability; d. Inherent buoyancy; e. Function of TEMPSC; f. Engine and helm position controls; g. Primary and secondary method of engine start; h. Deluge system; i. Life support system; j. Fuel system and location of valves; k. Ancillary equipment; l. Compass; m. Clearing installation and taking up safe position

DAVIT EXERCISE to include: a. Operation of lowering and release mechanism; b. Clearing away and preparation of TEMPSC prior to abandonment; c. Pre-abandonment checks; d. Boarding procedures; e. System of recovery

ABANDONMENT EXERCISE to include: a. TEMPSC muster; b. TEMPSC Preparation; c. Embarkation; d. Lowering and release

SEA EXERCISE to include: a. Steering; b. Recovery of man overboard; c. Streaming and recovery of sea anchor; d. Operation and firing of parachute rocket

TEMPSC THEORY to include: a. Single fall; b. Double fall; c. Use of TEMPSC emergency equipment and supplies.
FIREFIGHTING

ADMINISTRATION/INTRODUCTION/REVISION OF BASIC
FIREFIGHTING to include: a. Introduction; b. Objectives; c. Programme;
d. Safety

COMBUSTION THEORY to include: a. Fire spread; b. Fire extinction;
c. Classes of Fire

SELF RESCUE THEORY to include: a. Movement in smoke; b. Escape
breathing apparatus; c. Assisting others; d. Escape procedures; e. Self rescue

BA EXERCISE (PRACTICAL) to include: a. Protective clothing issue;
b. Donning BA; c. Walkabout; d. Visual Inspection; e. Operation of smoke
hoods

SMOKE HOUSE EXERCISE (PRACTICAL) to include: a. Group exercise;
b. Don short duration sets; c. Assisting each other; d. Subjection to real fire and
smoke conditions

GOOD HOUSEKEEPING to include: a. Fire prevention; b. Actions in an
emergency

PRACTICAL EXERCISE to include: a. Hose running dry; b. Hose running
wet; c. Monitor and branch pipe

EXTINGUISHER EXERCISE (PRACTICAL) to include: a. Extinguishing a
pan; b. Extinguishing fires with water; c. Extinguishing fires with foam;
d. Extinguishing fires with CO2
APPENDIX 2 - COURSE SPECIFIC QUESTIONNAIRES

CONFIDENTIAL

SUBJECT DETAILS - 1

Course: .................................................................................................................................

Personal Code: .................. Date: ......................................................................................

Order of Events (number from 1 to 4)

Firefighting ........ HUET ......... Abandonment ........ TEMPSC .............

Name: ..............................................................................................................................

Address: ...........................................................................................................................

...........................................................................................................................................

...........................................................................................................................................

Phone No: ......................... (Home): .............................................. (Aberdeen if different)

Age yrs: ......................... M/F

Occupation: .......................................................................................................................
SUBJECT DETAILS - 2

PERSONAL CODE: ............................................. DATE: ......................................

Directions: Please answer all questions below which are applicable to you. Be frank and where details are required be as specific as possible. Where "Yes" and "No" options are given, tick the appropriate box.

1. Are you presently in employment? □ (1) □ (2)

2. Have you ever worked offshore? □ (1) □ (2)

3. If yes; when was your last visit? Give date: ......................

4. When was your first visit? Give date: ......................

5. On average, how many weeks per year do/did you spend offshore? ................. wks

6. Have you taken part in survival training on a previous occasion? □ (1) □ (2)

7. If yes; what courses have you attended? Please give details of course type, place where the course was held and dates:

........................................................................................................................................

........................................................................................................................................

8. Do you smoke? □ (1) □ (2)

9. If yes; number of cigarettes per day? ............

10. Do you regularly participate in exercise or sport? □ (1) □ (2)

11. If yes; give details of exercise/sport type and how frequently you take part:

........................................................................................................................................
SUBJECT DETAILS - 3 PSE

PERSONAL CODE: ............................................. DATE: ..................

Please answer all of the following questions. If you have any queries ask the Research Officer. Where several options are given for your answer, please circle the option that you feel is most appropriate to you. Give answers which reflect yourself as honestly as possible. The information you supply may be used to improve the quality of course content in future.

12 What is your main reason for completing the offshore survival course?
   "Tick One"
   a) It will help me to get a job
      (1)
   b) It is a requirement for me to continue in my present job.
      (2)
   c) Other
      Please specify .........................................................

   (3)

13 How would you rate your physical fitness?
   Very fit (1)     Quite fit (2)     Adequate (3)     Unfit (4)

14 How would you rate your swimming ability?
   Very good (1)     Quite good (2)     Adequate (3)     Non-swimmer (4)

Do you have any previous knowledge or experience of:

15 Helicopter underwater escape?
   If yes, give details
   Yes (1)     No (2)

16 Abandonment procedures?
   If yes, give details .
   (1)     (2)

17 Firefighting?
   If yes, give details
   (1)     (2)

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18 Lifeboats?
If yes, give details

19 Of the following four exercises, which do you think you will handle most effectively?

"Tick One"

Lifeboats

Firefighting

Helicopter underwater escape

Abandonment procedures

20 Of the following four exercises, which do you think you will handle least effectively?

"Tick One"

Lifeboats

Firefighting

Helicopter underwater escape

Abandonment procedures

21 How much of an achievement would you consider completion of the course to be?

Great (1) Moderate (2) Slight (3) Zero (4)

Refreshers Only:

22 Do you think that completion of the refresher course will improve your confidence in your knowledge of survival techniques?

23 Which aspects of survival training do you think need to be practised at regular intervals?
Direction: Please answer all questions as honestly and frankly as possible. Where appropriate, tick the box which most applies to you, at this moment. All information will be treated in a confidential manner. The results of the evaluation may be used to modify training methods for the benefit of others.

26 Which aspect of the firefighting training did you find most difficult to cope with?

- Smoke (1)
- Dark (2)
- Claustrophobia (3)
- Disorientation (4)
- Physical Exertion (5)
- Heat (6)
- Flames (7)
- Remembering instructions (8)
- General Anxiety (9)

27 Which exercise did you find to be the most difficult?

- BA donning and walkabout (1)
- Cosmetic smoke exercise (2)
- Real smoke and no BA (3)
- Extinguisher practise (4)
- Valve isolation (5)
- Escape BA exercise - self rescue (6)

Why did you find this to be the most difficult? 

28 Are you satisfied with the way you coped with the firefighting training? (Please circle the response which you think best describes your feelings).

- Very well (1)
- Well (2)
- Somewhat (3)
- Not at all (4)
HELICOPTER UNDERWATER ESCAPE EVALUATION

PERSONAL CODE: .................................................. DATE: .................................................................

Directions: Please answer all questions as honestly and frankly as possible. Where appropriate, tick the box which most applies to you, at this moment. All information will be treated in a confidential manner. The results of the evaluation may be used to modify training methods for the benefit of others.

29 Which aspect of the helicopter underwater escape did you find most difficult to cope with?

- Swimming [ ] (1)
- Holding breath [ ] (2)
- Disorientation [ ] (3)
- Releasing seat belt [ ] (4)
- Finding exit [ ] (5)
- General anxiety [ ] (6)
- Remembering instructions [ ] (7)

30 Which exercise did you find to be the most difficult?

- Upright escape [ ] (1)
- Slow capsize [ ] (2)
- Fast capsize [ ] (3)

Why did you find this to be the most difficult? ..........................................................

.................................................................................................................................

.................................................................................................................................

31 Are you satisfied with the way you coped with the helicopter underwater escape training? (Please circle the response which you think best describes your feelings).

- Very well (1)
- Well (2)
- Somewhat (3)
- Not at all (4)
ABANDONMENT EVALUATION

PERSONAL CODE: .................................................. DATE: ........................................

Directions: Please answer all questions as honestly and frankly as possible. Where appropriate, tick the box which most applies to you, at this moment. All information will be treated in a confidential manner. The results of the evaluation may be used to modify training methods for the benefit of others.

32 Which aspect of the abandonment training did you find most difficult to cope with?

- Swimming in calm water  □ (1)
- Swimming in waves  □ (2)
- General physical activity  □ (3)
- Motion of liferaft  □ (4)
- General anxiety  □ (5)
- Remembering instructions  □ (6)

33 Which exercise did you find to be the most difficult?

- "Step off" water entry - low  □ (1)
- "Step off" water entry - high  □ (2)
- Descending knotted rope  □ (3)
- Climbing scramble nets  □ (4)
- Righting upturned liferaft  □ (5)
- Entering liferaft from water  □ (6)
- Towing casualty in water  □ (7)

Why did you find this to be the most difficult? ..................................................
........................................................................................................................................

34 Are you satisfied with the way you coped with the abandonment training? (Please circle the response which you think best describes your feelings).

- Very well (1)  
- Well (2)  
- Somewhat (3)  
- Not at all (4)

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TEMPSC EVALUATION

PERSONAL CODE: .................................................. DATE: .........................

Directions: Please answer all questions as honestly and frankly as possible. Where appropriate, tick the box which most applies to you, at this moment. All information will be treated in a confidential manner. The results of the evaluation may be used to modify training methods for the benefit of others.

35 Which aspect of the TEMPSC training did you find most difficult to cope with?

Boarding the craft  □ (1)
Finding seat and strapping in belt  □ (2)
Claustrophobia  □ (3)
Motion  □ (4)
Smell  □ (5)
Steering the craft  □ (6)
General anxiety  □ (7)
Remembering instructions  □ (8)

36 Which exercise did you find to be the most difficult?

Coxswain and mechanic training  □ (1)
Abandonment and launch from davits  □ (2)
Boat handling at sea  □ (3)

Why did you find this to be the most difficult? ..............................................

Coxswain and mechanics: Any specific problems? .................................

37 Are you satisfied with the way you coped with the TEMPSC training? (Please circle the response which you think best describes your feelings).

Very well (1)      Well (2)      Somewhat (3)      Not at all (4)
PERCEIVED OUTCOME

PERSONAL CODE: .............................................. DATE: ..............................................
Please circle the response which you think best describes your feelings.

38 How much more capable do you now feel of safely evacuating from an offshore installation, during an emergency, than you did prior to this training course?
   Much (1)    Moderately (2)    Slightly (3)    No change (4)

39 How much more capable do you now feel of coping with a fire, than you did prior to this training course?
   Much (1)    Moderately (2)    Slightly (3)    No change (4)

40 How much more capable do you now feel of coping with a helicopter ditching, than you did prior to this training course?
   Much (1)    Moderately (2)    Slightly (3)    No change (4)

41 Has the training altered your confidence in helicopter transport?
   Greatly increased (1)    Somewhat increased (2)    No difference (3)
   Somewhat decreased (4)    Greatly decreased (5)

42 Do you feel that the course has improved your knowledge of survival techniques?
   Much (1)    Moderately (2)    Slightly (3)    No change (4)

43 Do you think that the training has made you more able to cope with other emergency situations?
   Much (1)    Moderately (2)    Slightly (3)    No change (4)

Finally:
44 Was the training course as physically demanding as you expected?
   Much more (1)    Somewhat more (2)    As expected (3)
   Somewhat less (4)    Much less (5)

45 Was the training course as emotionally demanding as you expected?
   Much more (1)    Somewhat more (2)    As expected (3)
   Somewhat less (4)    Much less (5)

46 Was there any parts of the training which you consider to be more demanding than necessary?
   Please give details; ........................................................................................................
   ........................................................................................................
APPENDIX 3 - EXERCISE TEST PROTOCOL

PROTOCOL FOR AEROBIC FITNESS TEST

Fit subject with Heart Rate monitor (set at 5 second intervals) and ECG leads. With subject seated note resting heart rate.

Adjust seat height of cycle, such that subject’s leg is virtually straight, when pedal is at the lowest point.

Ask subject to commence cycling for 3 minutes at 50 RPM, with no load.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Qualifying criteria</th>
<th>Work Rate Increase (Watts)</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>Age (years)</td>
<td>Sedentary / Active</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 40</td>
<td>50 / 75</td>
<td>Until HR reaches a steady state*. Over a minimum of 4 minutes and maximum of 6 minutes.</td>
</tr>
<tr>
<td></td>
<td>&lt; 40</td>
<td>75 / 100</td>
<td></td>
</tr>
<tr>
<td>Second</td>
<td>Steady State (bpm)</td>
<td>All</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt; 110</td>
<td>50</td>
<td>Until steady state HR reached, as above</td>
</tr>
<tr>
<td></td>
<td>&gt; 110, &lt; 13</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 130</td>
<td>0</td>
<td>Discontinue, providing a steady state HR has been reached.</td>
</tr>
<tr>
<td>Third</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt; 125</td>
<td>50</td>
<td>Until steady state HR reached, as above.</td>
</tr>
<tr>
<td></td>
<td>&gt; 125, &lt; 15</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 150</td>
<td>0</td>
<td>Discontinue, as above.</td>
</tr>
</tbody>
</table>

Continue as per the third stage.

* Steady State Heart Rate - whereby a value is found which is the same on 3 consecutive readings.
BICYCLE ERGOMETER TEST

Personal Code

Date

Resting Heart Rate seated (bpm)

**Heart Rates (bpm)**

<table>
<thead>
<tr>
<th>Stopwatch Time (Minutes)</th>
<th>Work Rate (Watts)</th>
<th>Heart Rates (bpm) at minute:</th>
<th>Ratings of Percieved Exertion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
APPENDIX 4 - DATASET CODES

No.  Title

Subject number
Refresher (1) or Combined (2)

1. Are you presently in employment?
2. Have you ever worked offshore?
3. If yes, when was your last visit? Give date (Year) 
4. When was your first visit? Give date (Year) 
5. On average how many weeks do/did you spend offshore?
6. Have you taken part in survival training on a previous occasion?

7.
8. Do you smoke?
9. If yes; no. of cigarettes per day?
10. Do you regularly participate in exercise or sport?
11. Sport - times per week?
12. What is your main reason for completing the offshore survival course?
13. How would you rate your physical fitness?
14. How would you rate your swimming ability?
15. Experience of HUET?
16. Experience of Abandonment procedures?
17. Experience of Firefighting procedures?
18. Experience of Lifeboats?
19. Which exercise do you think you will handle most effectively?
20. Which exercise do you think you will handle least effectively?
21. How much of an achievement would you consider the course to be?
22. Do you think that completion of the refresher course will improve your confidence in your knowledge of survival techniques?

23.
24.
25.

26. Which aspect of the Firefighting training did you find most difficult to cope with?
27. Which exercise did you find to be the most difficult?
28. Are you satisfied with the way you coped with the firefighting training?
29. Which aspect of the HUET did you find most difficult to cope with?
30. Which exercise did you find to be the most difficult?
31. Are you satisfied with the way you coped with the HUET training?
32. Which aspect of the abandonment training did you find most difficult to cope with?
33. Which exercise did you find to be the most difficult?
34. Are you satisfied with the way you coped with the abandonment training?
35. Which aspect of the TEMPSC training did you find most difficult to cope with?
36. Which exercise did you find to be the most difficult?
37. Are you satisfied with the way you coped with the TEMPSC training?
38. How much more capable do you now feel of safely evacuating from an offshore installation, during an emergency, than you did prior to this training course?
39. How much more capable do you now feel of coping with a fire, than you did prior to this training course?
40. How much more capable do you now feel of coping with a helicopter ditching, than you did prior to this training course?
41. Has the training altered your confidence in helicopter transport?
42. Do you feel that the course has improved your
43. Do you think that the training has made you more able to cope with other emergency situations?
44. Was the training course as physically demanding as you expected?
45. Was the training course as emotionally demanding as you expected?
46. Day of last visit offshore?
47. Month of last visit offshore?
48. Day of first visit offshore?
49. Month of first visit offshore?
50. Height (cm)
51. Weight (kg)
52. Age (years)
53. % Body fat
54. Forced expiratory volume in 1 second
55. Forced vital capacity
56. Resting heart rate whilst seated (bpm)
57. Average heart rate at 50 watts
58. Average heart rate at 75 watts
59. Average heart rate at 100 watts
60. Average heart rate at 125 watts
61. Average heart rate at 150 watts
62. Heart rate recovery value over 1 minute
63. Rating of perceived exertion at 50 watts
64. Rating of perceived exertion at 75 watts
65. Rating of perceived exertion at 100 watts
66. Rating of perceived exertion at 125 watts
67. Rating of perceived exertion at 150 watts
68.
69.
70. State - Trait Anxiety Inventory Scores - Enrolment trait score
71. STAI - enrolment state score
72. STAI - second morning state score
73. STAI - third morning state score
74. STAI - fourth morning state score
75. STAI - fifth morning state score
76. STAI - pre-HUET state score
77. STAI - pre-Abandonment state score
78. STAI - pre-fire exercise state score
79. STAI - pre TEMPSC abandonment state score
80. Internal versus external focus of control score
81. Interest and preference test total score
82. Interest and preference test, thrill and adventure seeking score.
83. Interest and preference test, experience seeking score.
84. Interest and preference test, disinhibition score.
85. Interest and preference test, boredom susceptibility score.
86. 
87. 
88. 
89. 
90. Urinary cortisol against creatinine enrolment score (nmolL⁻¹/µmol.L⁻¹).
91. Urinary cortisol against creatinine second morning (nmolL⁻¹/µmol.L⁻¹).
92. Urinary cortisol against creatinine third morning (nmolL⁻¹/µmol.L⁻¹).
93. Urinary cortisol against creatinine fourth morning (nmolL⁻¹/µmol.L⁻¹).
94. Urinary cortisol against creatinine fifth morning (nmolL⁻¹/µmol.L⁻¹).
95. Absolute urinary cortisol at enrolment (nmol/L).
96. Absolute urinary cortisol second morning (nmol/L).
97. Absolute urinary cortisol third morning (nmol/L).
98. Absolute urinary cortisol fourth morning (nmol/L).
99. Absolute urinary cortisol fifth morning (nmol/L).
100. Salivary cortisol at enrolment(nmol/L).
101. Salivary cortisol before HUET(nmol/L).
102. Salivary cortisol after HUET(nmol/L).
103. Salivary cortisol before abandonment(nmol/L).
104. Salivary cortisol after abandonment(nmol/L).
105. Salivary cortisol before smoke BA exercise(nmol/L).
106. Salivary cortisol after smoke BA exercise(nmol/L).
107. Salivary cortisol before TEMPSC abandonment(nmol/L).
108. Salivary cortisol after TEMPSC abandonment(nmol/L).
109. Salivary cortisol before exercise test(nmol/L).
110. Salivary cortisol after exercise test(nmol/L).
111. 
112. 
113. 
114. 
115. 
116. Self measured heart rate value on second morning.
117. Self measured heart rate value on third morning.
118. Self measured heart rate value on fourth morning.
119. Self measured heart rate value on fifth morning.
120. Heart rate average over 5 minutes during HUET brief.
121. Heart rate average over 1 minute steady state prior to entering water for HUET.
122. Heart rate average during surface impact and partial submersion exercises - combined.
123. Heart rate average during slow and rapid capsizes - combined.
124. Heart rate average during refresher HUET exercises.
125. Percentage of time HR above 150bpm during 1st combined HUET exercises.
126. Percentage of time HR between 120 and 150bpm during 1st combined HUET exercises.
127. Percentage of time HR below 120bpm during 1st combined HUET exercises.
128. Percentage of time HR above 150bpm during 2nd combined HUET exercises.
129. Percentage of time HR between 120 and 150bpm during 2nd combined HUET exercises.
130. Percentage of time HR below 120bpm during 2nd combined HUET exercise.
131. Percentage of time HR above 150bpm during refresher HUET exercises.
132. Percentage of time HR between 120 and 150bpm during refresher HUET exercises.
133. Percentage of time HR below 120bpm during refresher HUET exercises.
134. Heart rate average post HUET.
135. Heart rate average for 1 minute steady state pre-abandonment.
136. Heart rate average during abandonment.
137. Heart rate average for 1 minute steady state during abandonment debrief.
138. Percentage of time HR above 150bpm during abandonment.
139. Percentage of time HR between 120 and 150bpm during abandonment.
140. Percentage of time HR below 120bpm during abandonment.
141. Heart rate average for 1 minute steady state during smoke BA exercise brief.
142. Heart rate average during smoke BA exercise.
143. Heart rate average for 1 minute steady state within 3 minutes post smoke BA.
144. Percentage of time HR above 150bpm during smoke BA exercise.
145. Percentage of time HR between 120 and 150bpm during smoke BA exercise.
146. Percentage of time HR below 120bpm during smoke BA exercise.
147. Heart rate average for 1 minute steady state during TEMPSC brief.
148. Heart rate average during 1st TEMPSC abandonment.
149. Heart rate average for 1 minute steady state post 1st TEMPSC abandonment.
150. Percentage of time HR above 150bpm during TEMPSC abandonment.
151. Percentage of time HR between 120 and 150bpm during TEMPSC abandonment.
152. Percentage of time HR below 120bpm during TEMPSC abandonment.
153. Average heart rate whilst at sea.
RGIT LIMITED

VOLUNTEER INFORMATION

Evaluation of Survival Training

This investigation has been designed to measure the physical and psychological effects of the survival training course on its participants. The information gained will help the company to evaluate the effectiveness of the training and as a result, to change procedures where necessary.

The physical reactions of your body will be measured by two means:

1) **Heart rate** - Your heart rate will be measured by small sensors taped to your chest, with a wrist-watch type monitor.

2) **Cortisol** - Cortisol is a hormone normally found in your body, which can be measured both in saliva and in urine. Each morning you will be asked to give a small urine sample. Saliva will be sampled on the morning of enrolment, as well as prior to and following some of the practical sessions.

Your emotional reaction to the training and your ability to cope will be assessed by various questionnaires which you will be asked to fill in at the start and completion of the course, as well as others prior to and following some of the practical sessions. You will also be given an activity book to be filled in either by yourself or by the experimenter.

In order to assess your physical fitness you will be asked to complete an exercise test. This involves cycling for 6 minutes at a time, at 2 or 3 rates of work. Body fat will be measured by taking a small pinch of skin at several sites.

Throughout the course your training officers will be in charge of all procedures and their instructions will always take priority over these measurements. The results of the tests made on you will be completely confidential and will not be passed on to your training officers or to your company/employer. All results will be stored in such a way that your name cannot be traced.

It is important to emphasise that you may withdraw your consent at any stage and that this will in no way affect the outcome of your survival training course. The experimenter may also stop taking measurements if appropriate.
CONSENT FORM

Name of Volunteer: .................................................................

Name of Principal Investigator: ................................................

Name of Study: Trainee Evaluation

I ...........................................................................................................

of ........................................................................................................

being over 16 years freely and voluntarily consent to take part in tests being undertaken in connection with a study of trainees which so far as is known should not carry any unusual risk.

I have read the volunteer information sheet on the above study. The nature and purpose of the tests to be undertaken in connection with this study have been explained to me by: ............................................................ I understand fully what is proposed to be done and under whose supervision the tests will be carried out. I have had the opportunity to discuss the details of the tests and to ask questions.

I have agreed to take part in the study as it has been outlined to me, but I understand that I am completely free to withdraw from the study or any part of the study at any time I wish, and that this will not affect the completion of the training course in any way.

I understand that while this procedure is part of a research project which has been approved by the Joint Ethical Committee, the procedure may be of no benefit to me personally but notwithstanding this, I voluntarily accept any risk associated with the procedure which is not directly attributable to negligence on the part of those undertaking the procedure.

Date: ............................................................................................

Signature: .....................................................................................

I confirm that I have explained the nature and purpose of the procedure(s) in respect of which consent has been given by the volunteer.

Date: ............................................................................................

Signature: .....................................................................................

Signature witnessed by:.................................................................
APPENDIX 6 - BASIC OUTCOMES OF ANALYSES ON STAI

**KEY**

<table>
<thead>
<tr>
<th></th>
<th>Swim</th>
<th>Fit</th>
<th>Smoke</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Very good</td>
<td>1</td>
<td>Very fit</td>
</tr>
<tr>
<td>2</td>
<td>Quite good</td>
<td>2</td>
<td>Quite fit</td>
</tr>
<tr>
<td>3</td>
<td>Adequate</td>
<td>3</td>
<td>Adequate</td>
</tr>
<tr>
<td>4</td>
<td>Non-swimmer</td>
<td>4</td>
<td>Unfit</td>
</tr>
</tbody>
</table>

**GLM of refresher subjects' STAI scores:**

**A - against event (or training activity), with covariates smoke, fit & swim**

<table>
<thead>
<tr>
<th>Source</th>
<th>P-value</th>
<th>Coef value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoke</td>
<td>0.002</td>
<td>-3.495</td>
</tr>
<tr>
<td>Fit</td>
<td>0.017</td>
<td>2.2788</td>
</tr>
<tr>
<td>Swim</td>
<td>0.374</td>
<td>0.6190</td>
</tr>
<tr>
<td>Event</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>

**B - against subject and event; with covariate sequence**

<table>
<thead>
<tr>
<th>Source</th>
<th>P-value</th>
<th>Coef value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sequence</td>
<td>0.532</td>
<td>-0.2303</td>
</tr>
<tr>
<td>Subject</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Event</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>

**C - against event; with covariate age**

<table>
<thead>
<tr>
<th>Source</th>
<th>P-value</th>
<th>Coef</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.023</td>
<td>-0.12797</td>
</tr>
<tr>
<td>Event</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>

**D - against sequence and event considered simultaneously (Seq+10Ev); with covariate age**

<table>
<thead>
<tr>
<th>Source</th>
<th>P</th>
<th>Coef</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.026</td>
<td>38.250</td>
</tr>
<tr>
<td>Seq+10Ev</td>
<td>0.000</td>
<td>-0.12520</td>
</tr>
</tbody>
</table>

**Two-way ANOVA of reduced number of refresher subjects' STAI scores against event & subject**

<table>
<thead>
<tr>
<th>Source</th>
<th>F value</th>
<th>F value from tables (p&lt;0.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Event</td>
<td>18.1</td>
<td>*</td>
</tr>
<tr>
<td>Subject</td>
<td>7.4</td>
<td>*</td>
</tr>
</tbody>
</table>

* denotes significance at the 1% level.
One-way ANOVA of refresher subjects' trait anxiety score against smoke

<table>
<thead>
<tr>
<th>Source</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoke</td>
<td>0.015</td>
</tr>
</tbody>
</table>

GLM of combined subjects' STAI scores:

A - against event; with covariates smoke, fit & swim

<table>
<thead>
<tr>
<th>Source</th>
<th>P</th>
<th>Coeff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoke</td>
<td>0.573</td>
<td>0.4977</td>
</tr>
<tr>
<td>Fit</td>
<td>0.000</td>
<td>5.3247</td>
</tr>
<tr>
<td>Swim</td>
<td>0.000</td>
<td>2.4990</td>
</tr>
<tr>
<td>Event</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>

B - against subject and event; with covariate sequence

<table>
<thead>
<tr>
<th>Source</th>
<th>P</th>
<th>Coeff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seq</td>
<td>0.000</td>
<td>38.720</td>
</tr>
<tr>
<td>Event</td>
<td>0.000</td>
<td>-0.7960</td>
</tr>
<tr>
<td>Subject</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>

C - against event; with covariate age

<table>
<thead>
<tr>
<th>Source</th>
<th>P</th>
<th>Coeff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.787</td>
<td>-0.01395</td>
</tr>
<tr>
<td>Event</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>

D - against sequence and event considered simultaneously; with covariate age

<table>
<thead>
<tr>
<th>Source</th>
<th>P</th>
<th>Coeff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.761</td>
<td>38.553</td>
</tr>
<tr>
<td>Seq + 10Ev</td>
<td>0.000</td>
<td>-0.01601</td>
</tr>
<tr>
<td>Error</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## APPENDIX 7 - BASIC OUTCOMES OF ANALYSES ON HR

### Combined subjects' results

<table>
<thead>
<tr>
<th>Difference</th>
<th>N</th>
<th>Mean</th>
<th>St.Dev</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A2-A1</td>
<td>38</td>
<td>28.842</td>
<td>15.954</td>
<td>0.0000</td>
</tr>
<tr>
<td>A3-A1</td>
<td>38</td>
<td>-5.658</td>
<td>12.486</td>
<td>0.0082</td>
</tr>
<tr>
<td>H2-H1</td>
<td>42</td>
<td>11.881</td>
<td>10.104</td>
<td>0.0000</td>
</tr>
<tr>
<td>H3-H1</td>
<td>42</td>
<td>15.048</td>
<td>12.591</td>
<td>0.0000</td>
</tr>
<tr>
<td>H4-H1</td>
<td>38</td>
<td>-7.079</td>
<td>17.073</td>
<td>0.015</td>
</tr>
<tr>
<td>F2-F1</td>
<td>34</td>
<td>47.559</td>
<td>12.837</td>
<td>0.0000</td>
</tr>
<tr>
<td>F3-F1</td>
<td>34</td>
<td>27.059</td>
<td>10.795</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

### Refresher subjects' results

<table>
<thead>
<tr>
<th>Difference</th>
<th>No</th>
<th>Mean</th>
<th>StDev</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A2-A1</td>
<td>43</td>
<td>32.512</td>
<td>14.181</td>
<td>0.0000</td>
</tr>
<tr>
<td>A3-A2</td>
<td>38</td>
<td>-30.553</td>
<td>13.781</td>
<td>0.0000</td>
</tr>
<tr>
<td>A3-A1</td>
<td>38</td>
<td>1.053</td>
<td>12.232</td>
<td>0.60</td>
</tr>
<tr>
<td>H3-H1</td>
<td>42</td>
<td>22.595</td>
<td>16.109</td>
<td>0.0000</td>
</tr>
<tr>
<td>H2-H1</td>
<td>45</td>
<td>21.467</td>
<td>15.526</td>
<td>0.0000</td>
</tr>
<tr>
<td>H3-H2</td>
<td>42</td>
<td>1.595</td>
<td>12.293</td>
<td>0.41</td>
</tr>
<tr>
<td>F2-F1</td>
<td>48</td>
<td>46.667</td>
<td>12.951</td>
<td>0.0000</td>
</tr>
<tr>
<td>F3-F2</td>
<td>48</td>
<td>-15.708</td>
<td>10.867</td>
<td>0.0000</td>
</tr>
<tr>
<td>F3-F1</td>
<td>48</td>
<td>30.953</td>
<td>14.293</td>
<td>0.0000</td>
</tr>
<tr>
<td>T2-T1</td>
<td>45</td>
<td>15.778</td>
<td>7.914</td>
<td>0.0000</td>
</tr>
<tr>
<td>T3-T1</td>
<td>44</td>
<td>-0.591</td>
<td>7.969</td>
<td>0.63</td>
</tr>
<tr>
<td>T3-T2</td>
<td>45</td>
<td>-16.267</td>
<td>9.471</td>
<td>0.0000</td>
</tr>
</tbody>
</table>