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Hours of Work and Rest of Canadian Ice Navigators On Board Foreign-Registered Vessels in Arctic Waters

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Prepared by

Leslie Buck, Jeremy Brooks and Robert Webb

Human*systems* Incorporated

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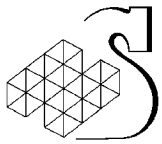

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16. Abstract

The aim of the study was to examine the work/rest schedules of ice navigators on board foreign-registered vessels in Canadian Arctic waters in relation to fatigue among ice navigators and the exigencies of operational requirements.

Seven experienced ice navigators were interviewed in two small focus groups and three participants kept logs of their activities during a total of seven voyages in Arctic waters. The data were reviewed in the light of recent scientific literature on hours of work and rest, and of the statutory regulations that prescribe hours of rest for shipping employees.

The interview data revealed the role of environmental and task conditions, workplace design, and work scheduling in producing fatigue. The interview participants recognized the role of fatigue in reducing the level of task performance, but regarded it as an acute rather than a chronic problem. The log data confirmed that, to the extent that fatigue occurred, it was an acute problem associated with periods of prolonged duty and with certain times of day.

The results of the study confirmed the feasibility for ice navigators, at least, of a previous recommendation that shipping employees observe fixed work schedules based on a 24 h period. Fatigue in shipping employees is determined by many factors and scheduling is a primary component. Regulating hours of rest is, however, an inadequate method of addressing that question. It should be addressed in terms of the time of day at which work is done and rest is taken, with hours of work and rest determined as a consequence of appropriate scheduling, and not the other way around.

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16. Résumé

Cette étude a pour but d'examiner les horaires de travail et de repos des officiers chargés de la navigation dans les eaux arctiques du Canada à bord de navires immatriculés à l'étranger, par rapport à leur niveau de fatigue et aux difficultés liées aux exigences opérationnelles.

Des interviews ont été réalisés auprès de sept officiers de navigation répartis en deux groupes de discussions et trois d'entre eux ont consigné la durée de diverses activités au cours d'une série de sept voyages dans les eaux arctiques. Les données recueillies ont été comparées sous l'angle des conclusions des dernières recherches scientifiques traitant des périodes de travail et de repos, et de la réglementation prescrivant les heures de repos des équipages des entreprises de transport maritime.

Les données recueillies durant les interviews ont montré la contribution de la configuration des lieux, de l'organisation temporelle du travail et des conditions créées par l'environnement comme par les tâches elles-mêmes à une certaine accumulation de fatigue. Les officiers interrogés ont reconnu le rôle de la fatigue dans la diminution de leur rendement au travail, mais estimaient qu'il s'agissait plutôt de fatigue aiguë que de fatigue accumulée. Les données consignées dans les journaux de bord ont confirmé que les problèmes de fatigue signalés relevaient d'une fatigue aiguë associée à de longues périodes de travail et à certains moments de la journée.

Les résultats de l'étude ont confirmé qu'il est possible, du moins dans le cas des officiers de navigation, de mettre en application une recommandation antérieure selon laquelle les équipages des entreprises de transport maritime devraient travailler selon des horaires fixes établis en fonction d'une période de 24 heures. La fatigue des équipages dans le secteur du transport maritime est attribuable à une combinaison de facteurs, dont l'un des plus importants est sans contredit l'organisation temporelle du travail. L'imposition d'heures de repos obligatoires ne constitue cependant pas une solution adéquate à ce problème. Il faut plutôt se pencher sur les divers moments de la journée réservés tantôt à l'exécution d'une tâche, tantôt à une période de repos, l'organisation du travail étant déterminée par les heures propres au travail et au repos, et non l'inverse.

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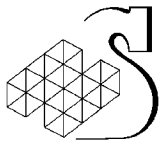


Executive Summary

This report describes a project commissioned by the Transportation Development Centre on behalf of TC, Marine, Prairie and Northern Region. The project was part of an investigation into hazards arising from shipping operations in Arctic waters.

Fatigue among shipping personnel is a recognized contributor to hazards in shipping operations. In an earlier project, Human*systems* Incorporated reviewed the role of statutory regulations in managing fatigue. That study examined (1) rest requirements for personnel, as indicated by scientific research and (2) operational requirements of the shipping industry. Both sets of requirements were taken into account in formulating proposed revisions to existing regulations.

The present project extended the previous study by examining the particular case of the operational requirements of ice navigators working on board foreign-registered vessels in Canadian Arctic waters.

In the circumstances under review, ice navigators act as pilots and advisors in guiding vessels through ice-infested waters. They are not permanent members of the crew and an ice navigator is often the only person on board having ice navigation skills. This imposes special difficulties with regard to the scheduling of their hours of work and rest.

Following a review of previous relevant studies of ice navigation, and of recent scientific research in work scheduling, pertinent data were collected. Operational information relating to ice navigators was collected by two methods:

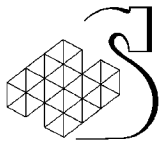
- Experienced ice navigators were interviewed in small focus groups;
- Ice navigators kept logs of their activities during voyages in Arctic waters.

Seven ice navigators were interviewed in two groups of three and four members each. They answered questions relating to their conditions of employment, tasks and duties, working and living conditions, work schedules, and experience of fatigue.

The data revealed the role of environmental and task conditions, workplace design, and work scheduling in producing fatigue. The interviewed participants recognized the role of fatigue in reducing the level of task performance, but regarded it as an acute rather than a chronic problem.

Three ice navigators recorded their duty and rest periods on a total of seven voyages in Arctic waters during the 1997 shipping season. In addition to recording the times of starting and ending periods of specified activity (sleep, naps, recreation, pauses, and duty), they made self-ratings on a linear tired/wakeful scale to indicate their fatigue level at the end of each period.

The data showed their work schedules and confirmed that fatigue was an acute rather than a chronic problem. To the extent that fatigue occurred, it was associated with periods of prolonged duty and with certain times of day.



In a previous report, Human*systems* Incorporated recommended that the statutory regulations be revised to include a requirement for shipping employees to observe fixed work schedules based on a 24 h period. Proposed revisions to regulations made by the Canadian Marine Advisory Council do not include this requirement.

The results of the present study indicate that in terms of the operational requirements of ice navigation and the actual practices of ice navigators, the recommendation is feasible. In the light of that finding and of the review of past scientific research, the present report reiterates the recommendation.

Fatigue in shipping employees is determined by many factors and work scheduling is a primary component. Regulating hours of rest is, however, an inadequate method of addressing that question. It should be addressed in terms of the time of day at which work is done and rest is taken, with hours of work and rest determined as a consequence of appropriate scheduling, and not the other way round.

The findings of the present study indicate that the current regulatory emphasis on hours of rest is also inappropriate in that it prescribes a minimal period of uninterrupted rest of six hours. Recent research indicates that this regulation may be unnecessarily stringent. The regulation is also difficult to observe in terms of the actual operational requirements of ice navigation.

The present study examined the relationship between work scheduling and subjective fatigue among ice navigators. Subjective fatigue (feeling tired) is of interest because it is associated with objectively measurable decrements in performance. Such performance decrements include performance errors that, in combination with other factors, may result in accidents.

A future study should examine the direct relationship between work scheduling and objectively measured changes in performance. Data relating to such changes exist in the form of reports of critical incidents. By examining the role of work scheduling in critical incidents, a broader assessment may be made of interrelationships among work scheduling, subjective fatigue, and performance decrements.

Sommaire

Ce rapport fait état d'un projet parrainé par le Centre de développement des transports pour le compte de Transports Canada, Région des Prairies et du Nord, Marine. Le projet a été lancé dans le cadre d'une étude portant sur les risques associés au transport maritime dans les eaux arctiques.

La fatigue du personnel affecté au transport des marchandises est un facteur de risques reconnu dans ce type d'activités. Au cours d'un projet antérieur, le groupe Human*systems* Incorporated s'est penché sur l'incidence de la réglementation sur les méthodes de gestion de la fatigue. Cette étude a examiné 1) les besoins de l'équipage au chapitre du repos, tels que mis en lumière par des recherches scientifiques, et 2) les exigences opérationnelles de l'industrie du transport maritime. Ces deux types d'exigences ont été prises en compte au moment de présenter des recommandations en vue de la révision de la réglementation.

Ce projet qui s'inscrit dans le prolongement des études précédentes porte sur la situation particulière posée par les exigences opérationnelles des officiers chargés de la navigation dans les eaux arctiques du Canada à bord de navires immatriculés à l'étranger.

Dans de telles circonstances, les officiers de navigation combinent les rôles de pilote et de conseiller afin de guider les navires dans les eaux chargées de glace. Ils ne font pas partie de l'équipage régulier du navire et seront, dans bien des cas, les seules personnes à bord ayant la moindre expérience de la navigation dans les glaces. Cette situation pose donc des difficultés particulières en ce qui a trait à l'organisation de leurs heures de travail et de repos.

L'examen des études antérieures sur la navigation dans les glaces et des dernières recherches scientifiques sur l'organisation temporelle du travail a permis de réunir les données pertinentes. Les renseignements relatifs aux fonctions du personnel naviguant ont été recueillis à l'aide des deux méthodes qui suivent :

- des entrevues de groupe ont été effectuées avec des officiers ayant l'expérience de la navigation dans les glaces; et
- les journaux de bord tenus par les officiers de navigation au cours de voyages dans les eaux arctiques ont été soigneusement étudiés.

Les interviews ont été réalisés auprès de sept officiers de navigation répartis en deux groupes respectivement composés de trois et quatre officiers. Les questions qui leur ont été posées portaient sur leurs conditions d'embauche, leurs diverses tâches et fonctions, les conditions de travail et de vie à bord des navires, les horaires de travail ainsi que le type et les niveaux de fatigue auxquels ils devaient faire face.

Les données rassemblées ont montré la contribution de la configuration des lieux, de l'organisation temporelle du travail et des conditions créées par l'environnement comme par les tâches elles-mêmes à une certaine accumulation de fatigue. Les officiers interrogés ont reconnu le rôle de la fatigue dans la diminution de leur rendement au travail, mais estimaient qu'il s'agissait plutôt de fatigue aiguë que de fatigue accumulée.

Trois officiers de navigation ont consigné leurs périodes de travail et de repos durant sept voyages dans les eaux arctiques effectués au cours de la saison de navigation 1997. En plus de noter l'heure au début et à la fin d'une activité spécifique (sommeil, petit somme, pause, divertissement et travail), ils

ont évalué leur niveau de fatigue à la fin de chaque période en fonction d'une échelle linéaire « *État de veille/état de fatigue* ».

Les données ont mis en lumière les répercussions de leur horaire de travail et elles ont confirmé que la fatigue constituait un problème épisodique plutôt que récurrent. La fatigue se manifestait pendant de longues périodes de travail et à certains moments au cours de la journée.

Dans un rapport antérieur, le groupe Human*systems* Incorporated a recommandé que la réglementation soit révisée et qu'elle précise la nécessité, pour les équipages des entreprises de transport maritime, de travailler selon des horaires fixes établis en fonction d'une période de 24 heures. Les modifications de la réglementation proposées par le Conseil consultatif maritime canadien ne traitent pas de cette exigence.

Les résultats de la présente étude indiquent qu'il est possible de mettre en application cette recommandation, compte tenu des exigences opérationnelles liées à la navigation dans les glaces et des règles de pratique courantes des officiers chargés de ce type de navigation. À la lumière de cette conclusion et de l'analyse des recherches scientifiques antérieures, le présent rapport réitère la validité de cette recommandation.

La fatigue des équipages des entreprises de transport maritime est attribuable à une combinaison de facteurs, dont l'un des plus importants est sans contredit l'organisation temporelle du travail. L'imposition d'heures de repos obligatoires ne constitue cependant pas une solution adéquate à ce problème. Il faut plutôt se pencher sur les divers moments de la journée réservés tantôt à l'exécution d'une tâche, tantôt à une période de repos, l'organisation du travail étant déterminée par les heures propres au travail et au repos, et non l'inverse.

Les conclusions de la présente étude révèlent que l'emphase de la réglementation actuelle sur les heures de repos est également inadéquate, puisque la période de repos minimale prescrite est de six heures de repos ininterrompu. Les recherches les plus récentes précisent que cette réglementation pourrait imposer des contraintes inutiles et que les exigences opérationnelles de la navigation dans les eaux chargées de glace pourrait rendre son application difficile.

Le projet a tenté de définir les rapports entre l'organisation temporelle du travail et le niveau subjectif de fatigue signalé par les officiers de navigation. L'intérêt de la fatigue subjective (le sentiment de fatigue) provient de son association avec des diminutions de rendement que l'on peut mesurer de façon objective. De telles diminutions de rendement entraînent des erreurs qui, lorsqu'elles sont combinées à d'autres facteurs, peuvent constituer une source d'accidents.

Une nouvelle étude devrait tenter de cerner les liens directs entre l'organisation temporelle du travail et les modifications de rendement que l'on peut mesurer objectivement. Les données se rapportant à de telles modifications existent déjà sous la forme de rapports d'incidents critiques. Un examen plus approfondi des répercussions de l'organisation temporelle du travail lors d'incidents critiques permettra d'évaluer de façon globale les interactions entre la fatigue subjective, l'organisation temporelle du travail et les diminutions de rendement.

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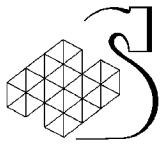

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1. Introduction

1.1. Outline

This report details the purpose, method, results and conclusions of the project entitled *Hours of Work and Rest of Canadian ice navigators on Board Foreign Registered Vessels in Arctic Waters*.

The report begins with a review of relevant previous work as well as recent literature. This is followed by descriptions and discussions of methods and results. The report concludes by re-iterating an earlier proposal that the statutory regulations be revised to emphasize an approach to fatigue management based upon work scheduling rather than one based upon hours of rest. Finally, the report makes a proposal for future work.

1.2. Aim of the study

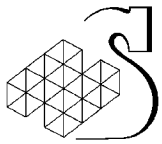
In the report of a previous project entitled *Review and revision of the Safe Manning Regulations,* Buck et al. (1995) recommended carrying out further research to that report. In particular, they recommended carrying out a survey of hours actually worked by shipping employees and a more extended survey of operational practices. The present project implemented these recommendations with respect to Canadian ice navigators on foreign-registered ships in Canadian Arctic waters.

The immediate objective of the present project, therefore, was to gather information about work/rest hours, shifts and scheduling of ice navigators and to review their operational practices. In broader terms, the objective was to respond to questions raised in the *Brander-Smith Report* (1990) concerning the role of fatigue in the performance of Masters, officers and crews in the shipping industry. The information reported here permits assessment of the impact of work schedules on the fatigue, alertness and sleep of ice navigators and thus provides details for a review of regulations aimed at ensuring a safe Arctic Marine Transportation System.

1.3. Method of the study

The study was based on a systems-design approach that regards human operators (in this case, the ice navigators) as one component in a multi-component system. From this perspective, any one part of the system, such as the operators' work/rest schedules, must be assessed and evaluated in the context of all other elements, and not as an isolated element. For this reason, the study encompassed, to the degree permitted by the scope of the project, a review of the task of ice navigators and of all their working conditions. As a point of departure for describing the ice navigators task, the study used the descriptions of Ice Navigating as it is performed on the M.V. Arctic (Buck and Webb 1992).

Apart from work/rest schedules, the study focussed on fatigue among ice navigators. Fatigue is more properly considered as a continuum ranging from extreme tiredness to full wakefulness, with fatigue itself representing only part of that continuum. Furthermore, fatigue (or tired/wakefulness) is regarded in this study as a subjective phenomenon that can be evaluated by those who experience it in terms of self-ratings. In other words ice navigators can state the extent to which they are tired or wakeful, and it was in these terms that it was measured in this study.



This study addressed the relationship between work/rest schedules and fatigue. In formal terms, work/rest scheduling was the independent variable and fatigue was the dependent variable. As implied by the *Brander-Smith Report* (1990), fatigue plays a role in the performance of ice navigators. Ultimately, interest lies in performance rather than fatigue but performance was not the focus of interest of this study.

2. Review of previous work

2.1. Previous studies of ice navigators

Two previous reports prepared by Human*systems* Incorporated described the task of ice navigators. The description in the first report (Buck and Webb 1992) was based on interviews and other data provided by officers who had sailed on the M.V. Arctic in Arctic waters and that in the second report (Webb and Greenley 1993) on observations made by the authors during a voyage on the M.V. Arctic from Bent Horn to Montreal. Taken together, these two reports provided a point of departure for preparing a description of the task of Canadian ice navigators on foreign-registered ships.

On the M.V. Arctic, an ice navigator is on duty on the bridge at all times while the ship is in ice-infested waters. One of these persons is the Master and the other a qualified Navigation Officer, the two standing alternate watches, usually of 6 h on and 6 h off, to ensure continuous coverage. Each may perform other duties when not on watch as the ice navigator.

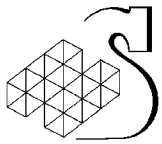
The task of the ice navigator on the M.V. Arctic is to control the con of ship, that is to set its course at an immediate tactical level taking into consideration to local ice and weather conditions. The strategic course is set by the Master and followed and plotted by the Officer On Watch.

The ship encounters ice of a different nature in various parts of the Arctic. In the north, the ice is thick, hard, multi-year ice moving south from the Arctic Ocean or else is first-year ice formed during the previous winter. Further south, ice coverage is less extensive and gives way to icebergs, bergy bits and growlers forming discreet pieces of floating ice of decreasing size that present obstacles of a different kind.

In general, the ice navigator attempts to keep the ship on the prescribed base course by staying in open water or possibly traversing very light ice conditions, while at all times trying to avoid heavy ice. This procedure is accomplished by conning the ship through verbal orders to the helmsman and these actions may also constitute guidance to the Officer On Watch. If the ship (in this case the M.V. Arctic) encounters pack ice the ice navigator has the options of going around it, pushing through it, or in extreme cases trying to break through the ice by ramming it. For icebergs, the only option is to go around. Thus the ice navigator must not only detect the presence of ice but also assess its nature and evaluate its strength. Various artificial instruments aid him, but his interpretations of direct visual cues and vibratory cues (given by the ship when it hits the ice) remain important components of his skill.

The ice navigator rarely steers the ship directly but gives instructions to the helmsman to do so. (The ice navigator does, however, have direct control of the engines.) Thus while all persons on the bridge may assist the ice navigator in keeping a look out, they all know which person has charge of navigation and who is responsible for instructing the helmsman. As ice navigators begin and end their periods of duty this responsibility is intentionally passed from one to another.

The task demands continuous attentiveness. The ice navigator must continually assess a constantly changing situation under varying conditions of visibility. To do this he must maintain appropriate lookout postures. These perceptual and postural aspects of the task are made more difficult by



changing weather and sea states. In addition, the watch must be maintained throughout a 24 h period including times when rest would normally be taken. When rest is taken, it may be disturbed by weather conditions and in other ways reduced in both quantity and quality.

In these circumstances, ice navigators inevitably become fatigued and their fatigue increases as a watch is prolonged. As they become fatigued, the task becomes more difficult for them and they become more liable to misperceive situations or make misjudgments or issue miscalculated commands. Furthermore, fatigue also decreases their ability to assess their own performance, that is they are less aware of their own mistakes.

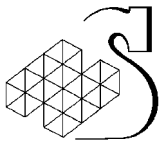
2.2. Recent relevant scientific literature

A third report prepared by Human*systems* Incorporated (Buck et al. 1995) reviewed the scientific literature relating to hours of work and hours of rest among shipping employees. In summary, the reviewers concluded that operators can be expected to maintain their performance for work periods of up to 12 h duration for three or six days and even up to 18 h duration on a single occasion. In the short term operators require at least 6 h sleep in a 24 h period, and in the longer term an average of 7.5 h sleep. More importantly, they emphasized the need to take account of the time of day at which work is done and rest is taken. In general, duty-rest schedules (that is, watchkeeping schedules) should follow a stable 24 h pattern that allows operators to work and rest at the same time from day to day.

Generally speaking, research workers have continued to address these issues with the same results. They have paid particular attention to work of 12 h duration because shifts of this length can be fitted into 24 h based shiftwork schedules to produce schedules that are attractive to both managers and operators. Performance during such shifts, compared to shorter shifts of 8 h duration (which can also be fitted into 24 h based shiftwork schedules), is often unaffected by the extended work period. Duchon et al. (1994) found that miners who had switched from an 8 h to a 12 h schedule reported improved sleep and showed, if anything, improvement in test battery performance (although some concomitant improvements in sleeping arrangements may also have affected the outcome). Williamson et al. (1994) found no change in productivity among computer operators who had changed from 8 h to 12 h shifts. Pollock et al. (1994) found no change in injury rates among operators in two manufacturing companies, although in one company injuries increased in severity.

However, 12 h may mark a critical limit. In an epidemiological study of several nuclear power plants, Baker et al. (1994) found that one index of performance safety correlated with working on a 12 h shift, although five other indices were uncorrelated and overtime working seemed to be more significantly correlated with safety indices than did 12 h shifts as such. Hamelin (1987) reported that truck drivers had an increased risk of accident after 11 h work. Rosa and Bonnet (1993) found that test battery performance was lower on a 12 h shift compared to a 8 h shift even though productivity data remained unchanged. Knauth et al. (1995) reported significant changes in alertness at the end of a 14 h shift among fire department dispatchers.

Knauth et al. pointed out that their findings may have reflected a time of day effect arising from the coincidence between the end of the shift and the trough of the normal circadian cycle of performance. This point - that performance is affected by time of day regardless of work duration - is made by virtually every researcher in this field. For example, from an epidemiological study among long-distance truck drivers Feyer and Williamson (1995) concluded that while fatigue depended on time



of day it was not always associated with long hours at work. In a related study Williamson and Feyer (1995) concluded that when they took account of the number of people at work, twice as many accidents (of which behavioural factors were the most common cause) occurred at night compared with the day. In other studies Smith and Folkard (1993) and Paley and Tepas (1994) reported, respectively, that nuclear power plant operators and firefighters slept for shorter periods and reported decreased attentiveness or increased sleepiness when they worked night shifts.

Similar emphases on time of day effects are found in two studies sponsored in part by Transport Canada, one dealing with locomotive engineers and the other with truck drivers. Locomotive engineers follow notoriously erratic work schedules, being required to start and finish work at any time within a 24 h cycle with no consistent pattern from one day to the next. Moore-Ede et al. (1996) based their study of locomotive engineers on the premise that schedule irregularity was the principal cause of fatigue in railway operations. They accordingly restricted day-to-day variation in time of starting work as the principal one of several countermeasures to fatigue. Results showed that it was operationally possible to implement this countermeasure and that it was effective in ensuring that locomotive engineers remained alert at their task.

In the truck driving study, Wylie et al. (1996) came to very similar conclusions. They found that when drivers became inattentive while driving, it was more likely to be associated with time of day than with duration of the current work period or number of days worked. They also found that for daytime driving considered alone there was no difference in attentiveness between drivers working 13 h shifts as against 10 h shifts. Both of these studies were notable in that they used a wide range of dependent measures including test-battery and real-life performance measures, physiological and electrographic measures, and self-rated and observer-rated subjective assessments.

Following their main study, Wylie et al. (1997) carried out a supplementary study of some of their subjects in order to assess the effects of length of rest period upon recovery of performance. For rest periods of 12 h and 48 h following four days of work they found no objective recovery effect among a small group of drivers. Among a larger group of 16 drivers taking 36 h off, they found that the main effect was in the amount of sleep taken, depending upon whether work began during the day or at night. In other words, they found another circadian rhythm effect. The only other minor change was in self-ratings of fatigue. Smiley and Haslegrave (1997) in a review of the literature on the subject of recovery during rest cited the Wylie et al. study as the only one that directly addressed the question.

The Wylie et al. (1996) and Moore-Ede et al. studies both applied the principle that the most effective countermeasure to sleepiness was to sleep, and accordingly allowed subjects to take naps under specified conditions. Moore-Ede et al. reported that the duration of naps, when taken, averaged 24 min and 27 min in two separate groups of locomotive engineers while Wylie et al. reported an average duration of 27 min for all truck drivers who took naps. Research workers continue to investigate the effectiveness of napping with the general finding that the practice delays or reverses the onset of fatigue. Rogers et al. (1989) found that decrements in test battery performance during nighttime experimental sessions were attenuated by a 1 h nap taken during the night, while Schweitzer et al. (1992) found similar results when a 2 h nap was taken just before the nighttime session began. At the same time, both studies found that attenuation was greater when caffeine was taken either during or just before the session.

2.3. Proposed changes to statutory regulations

In their report, Buck et al. (1995) proposed changes to Section 4 of the *Safe Manning Regulations* (*SMRs*) as they then existed (*CRC* 1978) based upon their review of the scientific literature and their assessment of operational requirements in the shipping industry. More recently, the Canadian Marine Advisory Council has published proposed *Crewing Regulations* (*CRs*) that consolidate, with other regulations promulgated under the *Canada Shipping Act*, the provisions previously included in the *SMR*s (Canada Gazette 1997).

Section 4 of the *SMRs* comprised six subsections. The corresponding sections of the consolidated *CRs* appear in Part I, Division II as Sections 13, 14 and 15 as shown in Table 2.1.

Table 2.1: Section 4 of the *SMRs* as represented in the *CRs*

SMRs	4(1)	4(2)	4(3)	4(4)	4(5)	4(6)
CRs	13(1), 13(2)a	--	13(3)	13(2)b	14	15

Section 4(2) of the *SMRs* has been dropped from the *CRs* while Sections 4(5) and 4(6) have been retained with minor changes in wording as Sections 14 and 15. Other changes in wording include substitution of *24 h period* for *calendar day* (and *48 h period* for *two consecutive calendar days*) and clarification (in Section 1 of the *CRs*) of the definition of *watch*. In other respects, the content of the regulations relating to hours of rest remains the same. The proposed introduction of regulations relating to hours of duty and to time of day at which work is done and rest is taken has not been adopted.

Both the old *SMRs* and the new *CRs* follow the well-established course of addressing the problem of fatigue by regulating hours of rest. This appears to be based on the conventional assumption that recovery from fatigue is directly proportional to the amount of rest taken and that if sufficient rest is taken excessive fatigue will not occur. In terms of this approach, it is important that operators receive sufficient sleep, or at least rest. Hours of work are not regulated directly but only obliquely, as a consequence of setting minimal limits to hours of rest. In the present case, Section 13 of the *CRs* sets a maximal limit to the time elapsing between periods of rest and thus, by implication, also to hours of work. The times of day at which work is done and rest is taken are not regulated at all.

3. Method

3.1. Outline

The objective of the study was to assess the work/rest schedules of ice navigators on foreign-registered ships in Canadian waters and to survey their operational practices. The investigators collected data by two techniques: (1) focus group interviews and discussions based on prepared questionnaire forms (Annex A), and (2) duty/rest logs used to record hours of duty and rest (Annex B).

3.2. Questionnaire form

The questionnaire form included a brief introduction to the purpose of the study and to Human*systems* Incorporated and instructions for completing the questionnaire. The questions covered five topics related to Canadian ice navigators working on board foreign-registered ships in Arctic waters:

1. general conditions of employment,
2. ice navigators' tasks and duties,
3. working and living conditions,
4. work schedules, and
5. fatigue.

Section 1 related to current experience as ice navigators on foreign-registered ships and previous experience on Canadian ships. It included a map of the Canadian Arctic on which respondents could describe working conditions and experiences in relation to locations.

Section 2 used the results of previous studies carried out on board M.V. Arctic as a basis for describing the duties of ice navigators in the circumstances of the present study. Respondents were asked to modify the previous results by adding and deleting material in order to produce an accurate account of their own situation.

Section 3 presented checklists for describing working and living conditions on board ship. Where conditions were rated as poor, respondents were asked to amplify their responses.

Section 4 related to actual and theoretical hours of duty and sleep. For this purpose, ice navigation duties were distinguished from other duties and sleep was distinguished from other time off duty.

Section 5 presented checklists for describing fatigue and its perceived symptoms. For this purpose, fatigue relating to hours of duty and rest was distinguished from fatigue relating to workload. In the context of this question respondents were asked for their opinions about how fatigue could be alleviated.

3.3. Duty/rest log

In designing the duty/rest log, the investigators applied three criteria: to avoid imposing excessive additional work upon ice navigators who were already busy enough, to produce a booklet that could be carried in a shirt or jacket pocket, and to collect the necessary data. The investigators believed that a log that created too much extra work for the ice navigator, that was too big to carry, and that asked for unnecessary information would have produced inaccurate information or no information at all. An example of the log is shown in Annex B.

The duty/rest log produced with these criteria in mind took the form of a 16 cm x 11 cm booklet containing 68 pages plus a cover. Following instructions for completing the log and returning it to the investigator, the log contained samples of possible entries. Most pages were blank forms for recording data.

The log distinguished between duty and rest, and, in the case of rest, between sleep and rest taken when not asleep. Sleep was defined as time spent in a bunk with the intention of falling asleep whether it was actually experienced as sleep or not. In addition to these three categories of activity, the log distinguished pauses and naps. A pause was defined as a brief rest taken during duty for eating or personal needs when bridge command was handed to another person. Naps were defined as either a brief period of sleep taken while on duty in a chair or similar situation, or a brief period of sleep taken while not on duty in a chair or in a bunk without changing clothes.

For recording purposes, a code was assigned to each activity as follows:

- dp duty period - time on duty spent working
- slp sleep - time spent in a bunk with the intention of falling asleep
- rec recreation - all other rest time
- ps pause - brief rests taken during duty for eating drinking or personal needs
- np nap - includes naps taken during duty or rest

  During duty a nap is a brief period of sleep taken in a chair or similar situation. During rest a nap is taken in a chair or briefly lying on a bunk without changing clothes.

In addition to noting the category and the time and date at which each activity began and ended, the log requested respondents to rate their tiredness on a linear scale. The ends of the 52 mm scale, marked by 3 mm vertical lines, were labeled *very tired* and *very wakeful*, and the 26 mm mid-point was similarly marked and labeled *borderline*. The intervening points were labeled *tired* and *wakeful* but were unmarked.

3.4. Participants

Project officers of TC, Marine, Prairie and Northern Region and the Transportation Development Centre recruited seven experienced ice navigators to act as the participants in the study. Six of the seven participants worked as ice navigators on foreign-registered ships in Canadian Arctic waters. The other participant had had no experience as an ice navigator on foreign-registered ships but was included as a participant because of his other experience as an ice navigator in Arctic waters. All participated voluntarily and without payment. Further details of the participants are given in the data analysis section.

3.5. Interview sessions

Participants attended one of two interview sessions in June 1997, the first in Ottawa conducted in English and the second in Montreal conducted in French. The principal investigator conducted the interviews, assisted by the project officers. A staff member of Fednav International Ltd. attended the Ottawa session. In each case the participants were interviewed as a group.

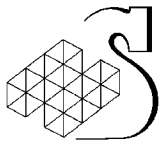
The interview sessions began with descriptions of the aims of the study, emphasizing the aspect of marine safety, and descriptions of Human*systems* Incorporated, emphasizing its impartiality. The participants were assured of individual anonymity in the reporting of data.

Following the introduction, participants were asked to complete the questionnaire form while, at the same time, discussing both the questions and their responses in an open-ended manner. When the questionnaires had been completed, the investigator introduced the sleep/activity logs and described how they were to be completed. Participants were asked to complete the logs during voyages undertaken during the coming season, and to return the completed logs directly to Human*systems* Incorporated.

Immediately following both interview sessions, the principal investigator wrote to each participant thanking him for his contribution to the interview sessions and reiterating the request that he complete the duty/rest log. Two months later second letters were sent to each participant reminding him of the importance that the duty/rest log data held for the successful outcome of the study.

3.6. Supplementary information

Fednav International Ltd. supplied supplementary information in the form of copies of ice navigators reports. These reports, prepared by ice navigators as part of their duties, included time-and-position logs, logs of ice conditions, ice analysis maps issued by the Canadian Ice Service of Environment Canada, and narrative descriptions of certain voyages. They were made available at the end of the Arctic shipping season.



4. Results

4.1. Outline

Questionnaire data were collected during two group interviews from a total of seven participants. This information provided an account of the operational practices of ice navigators on foreign-registered ships in Canadian Arctic waters. Completed duty/rest logs were received from three participants who between them recorded data for seven voyages in the Arctic. This information provided an account of their work/rest schedules and of the fatigue that they experienced.

4.2. Questionnaire data

The questionnaire responses were partly numerical in form and partly made up of written comments. The numerical data were collated and are presented here as means and ranges. The written comments were categorized and are presented as paraphrased summaries of the statements made by the participants. The presentation tries to avoid weighting the comments in the sense of judging one to be more significant than another. It should also be noted that the participants were not always consistent in their responses, either with one another or among themselves.

4.2.1. General conditions of employment

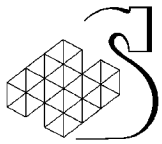
The participants had a mean age of 46.3, ranging from 37 years to 51 years. The six participants with experience of Ice Navigating on foreign-registered ships reported that before 1997 they had spent a mean of 6.8 years (ranging from one to 25 years) working in that capacity and as such had completed between two and 95 voyages.

All participants had worked as qualified Masters on Canadian ships before working as ice navigators on foreign-registered ships. They reported normal career progressions from Cadet or Helmsman through the ranks of third, second and first officers to Master, covering periods of up to 28 years. Previous experience was in some cases worldwide and in all cases included voyages in ice-infested waters in, the Western and Eastern Arctic, the Labrador coast, the Gulf of St. Lawrence and further afield in the Baltic and the Antarctic. The ships included general cargo ships, tankers, bulk carriers, offshore supply ships and tugs.

The participants reported that a season's work as ice navigators on foreign-registered ships in Canadian Arctic waters during the previous four years had lasted from June or July until October or November, and that they had sailed on between one and four voyages. Some reported that they had worked at other times of the year (between January and August) in the Gulf of St. Lawrence.

Three participants used the maps included in the questionnaire form to describe voyages as ice navigators in Arctic waters. Two of these were on foreign-registered ships and one on a Canadian-registered ship. The third voyage had begun and ended at Montreal and the ice navigator was present during the whole voyage. The other two either began or ended at a transatlantic port and the ice navigator was on board ship only during part of the voyage.

The voyages lasted 21, 23 and 35 days. The ships called at ports on the south, west and north coasts of Baffin Island, on islands to the north of Baffin Island, and in Greenland. The ships passed, therefore, through the Labrador Sea, Davis Strait, Baffin Bay and Lancaster Sound, as well as other ice-infested waters.



The participants described a variety of sea conditions. Although their descriptions were not identical, the general picture included bergy bits and growlers in Davis Strait, first-, second- and multi-year pack ice with four to nine tenths coverage further north, and medium to thick first-year ice further west. They also mentioned fog.

4.2.2. ice navigators' tasks and duties

Instead of attempting to generate a task description from original data, participants were presented with a description of the ice navigator's task as it was performed on the M.V. Arctic and asked to modify it as required. This technique worked well in the sense of generating data, though the participants challenged the choice of the M.V. Arctic as a model.

Five of the participants stated that the description did not accurately and fully describe the work done by ice navigators on foreign-registered ships in northern waters; one stated that it did and one stated that it did in general terms. All participants made modifications to the description, either directly to the text or by separate specification. About fifty such items were identified some of which were repeated by more than one participant. They were classified into six categories whose contents are summarized below.

4.2.2.1.Status of ice navigators

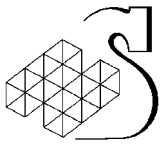
Participants emphasized that ice navigators have the con of the ship (that is, the immediate tactical responsibility for its heading and speed) and not responsibility for strategic location and navigation. The Officer On Watch has responsibility for navigation, while the ultimate responsibility rests with the Master. In this capacity, ice navigators give direct instruction to the helmsman but give engine orders to the Officer On Watch. All personnel on the bridge know when the ice navigator has the con of the ship.

4.2.2.2.Role of ice navigators in navigation

ice navigators play an advisory role in assisting the Master to interpret ice-related information in order to select a route through the ice and to carry out tactical maneuvering. It is important that the Master be sufficiently experienced to understand the rationale behind the advice and to appreciate the dangers inherent in the situation. It may be necessary for them to instruct inexperienced foreign officers in the principles of ice navigation.

4.2.2.3.Role of ice navigators in convoy handling

Foreign-registered ships often require escort by icebreakers. ice navigators communicate with shore stations and with icebreakers in order to arrange escorts and to manage the convoys that are formed for this purpose. Convoys consist of at least the icebreaker and one ship and may include more. Once in convoy, control of the ship requires patience and compliance with commands from the icebreaker. The task thus demands continuous attentiveness because of the added risk of collision with other ships in the convoy.



4.2.2.4.Ice breaking capabilities

Participants emphasized that the lack of icebreaking capabilities on the part of foreign-registered ships (which are only ice strengthened as compared to the M.V. Arctic which is an Arctic Class 3 icebreaker), make the task of ice navigation altogether different. These ships can never ram ice to go through it, and can only push it if it cannot be avoided. If they cannot go around the ice the Master must either change the route or request the assistance of an icebreaker.

4.2.2.5.Watchkeeping systems

Apart from the question of icebreaking capabilities, the situation on foreign-registered ships as compared to the M.V. Arctic differs significantly because the former have only one ice navigator on board. For this reason, there is no possibility of working an alternate watchkeeping system, and responsibility for ice navigation cannot be passed from one ice navigator to another. The periods that the ice navigator will work while the ship is in ice are often established at the start of the voyage. If the ice navigator is not on duty, the con of the ship is taken by the Officer On Watch.

4.2.2.6.Fatigue

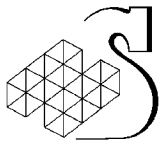
If the ship remains in ice, and the ice navigator must take rest, the options of stopping the ship is available. In this case, sleep is not disturbed by engine noise or by ice breaking. However, fatigue among ice navigators is generally underestimated.

4.2.3. Working and living conditions

Table 4.1 shows the means of the percentage ratings assigned by participants to each of the working conditions listed in Question 3.1. No participant added other conditions to the list. The data show that working conditions were generally rated as satisfactory or good. Of those receiving ratings of poor, *visibility through windows* and *Master's experience* were the most notable.

Condition	poor	satisfactory	good
general cleanliness	0	52.9	47.1
general layout	4.3	47.1	48.6
presence of instruments	3.6	56.4	40.0
condition of instruments	2.9	30.7	66.4
visibility through windows	14.3	52.9	32.8
heating, ventilation	3.6	41.4	55.0
Communications with others	7.2	55.7	37.1
Master’s experience	42.9	32.1	25.0
All conditions	**9.8**	**46.2**	**44.0**

Table 4.1: Mean percentage ratings of general working conditions



Regarding visibility from the bridge, participants noted in their comments the absence of means of heating and cleaning windows, the absence of searchlights or their relative low power and lack of remote control, and the presence of centreline cranes necessitating continual movement from side to side. One participant noted that bridge layouts are often outdated and one that VHF equipment is available on only one side of the bridge.

Regarding the Master's experience, participants noted that some Masters have had no previous experience of ice-infested waters, making it difficult to explain navigational requirements. This was compounded by an inability to speak English among the officers.

Table 4.2 shows the means of the percentage ratings assigned by participants to each of the living conditions listed in Question 3.5. No participant added other conditions to the list. The data show that living conditions were generally rated as satisfactory or good. The condition *communicating with others* received most ratings of poor. In this connection one participant noted the inability of the officers to speak English. This point was reflected in Table 4.1 where *communicating with others* received the third highest mean rating of poor. Taken also with the comment on VHF equipment, it suggests that communications may require attention.

	poor	satisfactory	good
Food	2.8	57.9	39.3
Communications with others	11.4	57.1	31.5
Sleeping	2.1	50.0	47.9
Heating, ventilation	2.8	55.0	42.2
All conditions	4.8	55.0	40.2

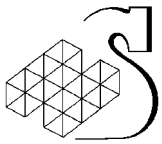
Table 4.2: Mean percentage ratings of general living conditions

Six participants felt that their work had never been seriously compromised by poor working or living conditions. However, one participant felt that his work was seriously compromised by fatigue and the need to be available for work for 24 h each day.

4.2.4. Hours of duty and sleep

4.2.4.1.Watchkeeping schedule

Participants reported that they did not follow a basic watchkeeping schedule. One participant emphasized that they were available (and sometimes present) for duty for 24 h. In those circumstances, most participants were reticent to estimate their mean hours on duty but reported their maximum hours on duty as being between 18 h and 24 h. In the case where a ship was about to "clear ice" and hence reach port, for example, the ice navigator remained on continuous duty. Two participants reported hours spent on duties other than ice navigation (2 h and 3 h) but five reported no hours spent on other duties. Other evidence indicated that ice navigators had log recording tasks that constituted, in effect, other duties.



4.2.4.2.Hours of sleep

Most participants reported broken sleep of between 4 h and 6 h in a 24 h period, although one reported 7 h and one 10 h. One participant felt that he did not have enough hours of sleep on average. The other six felt that they had enough hours of sleep on average but most emphasized that in certain 24 h periods they did not.

4.2.4.3.Quality of sleep

Four participants felt that their sleep was of adequate quality and three that it was not. In commenting on this topic, participants noted that sleep was intermittent and taken in short and discontinuous periods and that it was difficult to relax following stressful periods on duty particularly if sleep was taken while the ship remained in difficult circumstances such as heavy ice or poor weather.

4.2.5. Fatigue

One participant stated that he was never fatigued. Of the remaining six, one stated that he was fatigued but did not rate the frequency, one that he was rarely fatigued, three that they were seldom fatigued, and another that he was fatigued as often as not.

Among them, participants selected all of the items listed in Question 5.2 as reasons for fatigue attributable to times of work and rest, but they did not write in additional items. Table 4.3 lists items ranked according to the number of times each was selected. One participant added that fatigue lasted for only short periods.

Duty too long	6
Duty too erratic	4
Rest over several days too short	4
Duty at night	4
Too few opportunities for naps	4
Sleep too short	4
Sleep disturbed or poor quality	4
Rest immediately before duty too short	3
Too few opportunities for pauses	3
Duty very early in the morning	2
Duty in the evening	2
Total number of selections	**40**

Note: Entries are numbers of times each item was selected

Table 4.3: Duty and rest factors causing fatigue

Similarly, participants selected all of the items listed in Question 5.3 as reasons for fatigue attributable to workload. In addition, they wrote in three items. Table 4.4 lists items ranked according to the number of times each was selected. Again, one participant added that fatigue lasted for only short periods.

Need to stand for long periods	5
Ice conditions	4
Bad visibility	4
Ship under escort	4*
Bridge conditions	1
Difficulties with Master or crew	1
Sea conditions	1*
Fog and bad visibility	1*
Total	**21**

Note: Entries are numbers of times each item was selected.

Asterisked items were written in.

Table 4.4: Workload factors causing fatigue

Responses to Question 5.4 of *occasionally* were assigned a value of 1 and responses of *often* a value of 2. Table 4.5 shows the items ranked according to total scores. All items had scores greater than zero, indicating that all symptoms had been experienced at some time by these seven participants. One participant wrote in that he had occasionally said "port" when he meant "starboard" and vice versa. One participant wrote that he stopped the ship or passed the con to the Master when he felt too fatigued to continue.

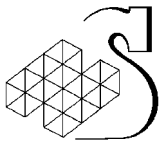
Desire to sit or lay down	10
Sore muscles	8
Heavy eyelids	6
Clumsy	5
Easily distracted	4
Difficulty focussing attention	4
Forgetfulness	3
Did things at the wrong time	3
Low motivation	2
Saying port instead of starboard	1*
Total	**46**

Note: Entries are weighted frequency assignments (occasionally = 1, often = 2).

Asterisked entry was written in.

Table 4.5: Fatigue symptoms

Three participants assessed fatigue as a problem that was *moderately serious* and four as *hardly serious at all*. One participant stated that with relatively few days in ice he considered his personal fatigue to be manageable. As far as solutions to the problem were concerned, three participants offered a total of five suggestions. One was to stop the ship to allow the ice navigator to take more sleep. The other



four were to assign two ice navigators (or to carry a relief ice navigator) and to ensure that the Master (or the Officer On Watch) was competent to navigate in ice.

4.2.6. Verbal comments

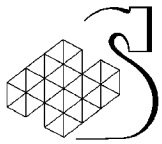
As the participants completed the questionnaire forms, they discussed questions and responses. The verbal comments generally reflected the written responses described in the previous sections. At the same time they served to emphasize certain points including some of the presuppositions lying behind the construction of the questionnaire. The following summary paraphrases this material.

The M.V. Arctic is an exceptional ship compared to the foreign-registered ships in Canadian Arctic waters forming the focus of the study. The M.V. Arctic is an icebreaker carrying (like other Canadian ships) officers and crew with experience in ice, and as such is relatively easy to work on. Ice navigation on foreign-registered ships having a lower ice class contrasts with this in at least two important respects. ice navigators must often pilot ships as part of a convoy following an icebreaker, implying a higher risk of collision; and the ice navigator is usually the only qualified ice navigator on board with sole responsibility for dealing with the situation.

This has two consequences in terms of fatigue: the task carries additional stress and no relief is available to allow for adequate rest at all times. (Stress may be further increased in these circumstances if, as some participants claimed, some foreign-registered ships do not carry ice navigators.) No watchkeeping system with appropriate duty-rest cycles can be established. The ice navigator is at least on call for 24 h and in practice often on duty for that period. As a last resort, the ice navigator can stop the ship in order to take rest, and this sometimes happens, but it is clearly difficult to do in a situation where the ice navigator (or his company) is under contract and he is under pressure to supply the contracted service.

The ice navigator has the con of the ship and acts in practice as a pilot, although he is not usually described as such. Masters on foreign-registered ships are most often inexperienced in ice-infested waters. They retain ultimate responsibility for the ship and need to be reassured about its safety. In theory the Master can override the instructions of the ice navigator. The ice navigator must, therefore, establish a good rapport with the Master that will lead to mutual trust. This is one of the first tasks to accomplish when coming on board.

While recognizing the relevance of these conditions regarding fatigue, most participants thought that fatigue was an acute rather than a chronic problem. At times the situation became very difficult: it was difficult to find time to sleep and difficult to sleep when time was found, but these times occurred infrequently and erratically, depending on ice, sea and weather conditions. The participants were not, however, able to quantify these periods.



4.3. Duty/rest log data

At the end of the summer season, Human*systems* Incorporated received completed duty/rest logs from three members of the original group of ice navigators participating in the study. These logs reported duty and sleep patterns of ice navigators on seven 1997 voyages, three undertaken by one respondent and two each by the other two. In addition, Human*systems* Incorporated received from Fednav International Ltd. copies of reports corresponding to four of the voyages reported in the duty/rest logs.

4.3.1. General description of the voyages

The seven voyages were made between July and September 1997. The Fednav reports showed that for the four voyages in question foreign-registered class 1 ships made inbound voyages to Arctic ports from ports in the United States and Europe and outbound voyages to ports in Europe. The respondents joined and left the ships at the foreign ports but acted in the capacity of ice navigator only while the ships were in the Shipping Safety Control Zones north 60°N latitude.

On the four inbound voyages the ships encountered conditions similar to those previously described by the participants in the interview sessions. The ships encountered open or bergy water as they passed 60°N latitude, met their first icebergs and bergy bits as they sailed into Davis Strait, and then met moving pack ice in Lancaster Sound and fast pack ice further west. On the four outbound voyages these conditions were met in reverse order. The ships met more extensive pack ice on the earlier voyages and less on the later. Poor visibility due to fog and falling snow was encountered at various parts of the voyages.

When sailing without icebreaker escort the ice navigators sought leads of open water that would take the ship around the pack ice. When sailing with escort in the more northerly waters they followed the leads created by the icebreaker and relied on the icebreaker to free the ship if it were beset by the pack ice.

4.3.2. Activity data

The duty/rest logs showed that the ships spent between 11 and 15 days in the Shipping Safety Control Zones and between two and six days at the Arctic port, in each case inclusive of the days entering and departing. The respondents completed the logs on between 11 and 13 days of the voyage, with gaps occurring in some cases while the ship was in the Arctic port. They logged a total of 537 activity periods. Table 4.6 shows how these activities were distributed among the five categories ordered in terms of degree of involvement with work.

Approximately one sleep period was entered for every day logged. All logs included naps but these were not numerous. The pattern of entries for the recreation and pause categories suggests that these two categories may not have been sufficiently well differentiated by the investigators. Some respondents may have logged certain periods as recreation while others logged equivalent periods as pauses. With respect to the duty category, there is a major difference between Voyages 4 and 7 and the other five. Additional notes entered by the respondents suggest that a distinction was made between duty when holding the con and duty otherwise, with the latter (especially if it involved paperwork) sometimes entered as recreation. Alternatively, it may have been that on those voyages the respondent worked duty in single prolonged periods rather than as more frequent shorter periods interrupted by recreation and pauses.

Voyage	Days logged	Activity					Total
		sleep	nap	recreation	pause	duty	
1	13	18	5	32	14	40	109
2	11	15	3	3	21	29	72
3	11	13	3	37	9	34	96
4	11	12	1	19	0	8	40
5	11	13	4	9	28	30	84
6	12	11	4	47	1	32	95
7	11	15	3	15	0	8	41
Total	**80**	**97**	**23**	**162**	**74**	**181**	**537**

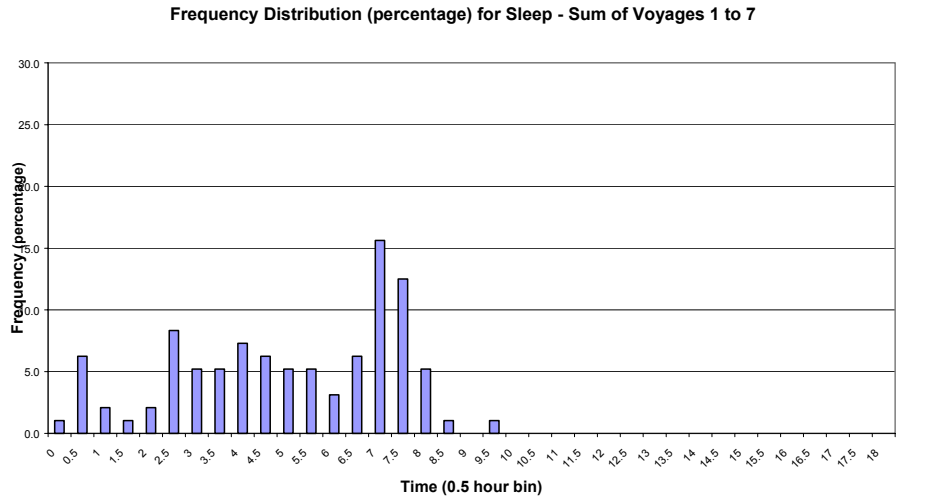
Table 4.6: Distribution of activities

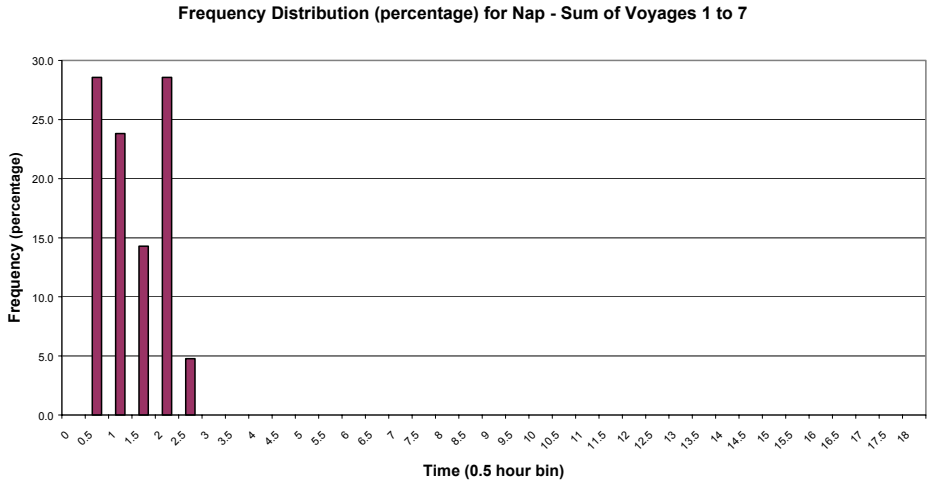
Table 4.7 shows the mean and maximum duration of each activity on each voyage, and the overall means for voyages based upon pooled data. The periods of activity ranged in duration from 10 min for the shortest pause to 18 h for the longest recreation period. The shortest periods were pauses, and these were followed by naps. Naps were shorter than sleep periods. Sleep periods varied between voyages with Voyage 2 showing a mean of 4 h 6 min and Voyage 6 a mean of 7 h 13 min. Mean duties varied between voyages ranging from 2 h 19 min for Voyage 6 to 8 h 28 min for Voyage 7. The longest recorded duty period was one of 17 h 40 min.

Voyage	Activity (hours:minutes)									
	sleep		nap		recreation		pause		duty	
	mean	max	mean	max	mean	max	mean	max	mean	max
1	4:52	9:40	1:25	2:10	3:28	16:20	0:36	1:10	3:19	16:05
2	4:06	7:00	2:20	2:30	3:00	4:00	0:36	2:00	5:28	12:30
3	5:55	8:20	1:18	1:30	2:20	14:45	0:27	0:40	2:30	8:05
4	5:57	8:00	0:45	0:45	7:34	17:00	-	-	5:13	17:35
5	5:05	7:05	2:15	3:00	2:43	6:00	0:34	2:30	4:42	11:30
6	7:13	8:05	1:38	2:15	2:43	18:00	0:10	0:10	2:19	15:55
7	5:12	8:50	1:02	1:15	8:17	17:00	-	-	8:28	17:40
Overall	5:22	9:40	1:39	3:00	3:52	18:00	0:34	2:30	3:52	17:40

Table 4.7: Duration of activity

Figure 4.1 shows the distribution of duration values for each activity pooled for all voyages. No statistical technique was applied to the distributions and the results described here, based on visual inspection. Sleep periods fell into three ranges: 0.5-2 h (10%), 2.5-6 h (45%) and 6.5-10 h (45%). Naps fell into two ranges corresponding to the two lower sleep ranges: 0.5-2 h (67%) and 2.5-3 h (33%). Recreation periods fell into four ranges: 0.5-2 h (52%), 2.5-5 h (27%), 5.5-9.5 h (11%) and 12-18 h (10%) and pauses into one range corresponding to the lowest of the recreation ranges (100%). This supports the suggestion that respondents did not differentiate in a consistent manner between recreation periods and pauses. The distribution of duty periods is the most uneven of the five distributions. At the lower end of the distribution it is possible to distinguish as many as three ranges: 0.5-2 h (38%), 2.5-4.5 h (31%) and 5-7.5 h (15%). At the upper end the remainder of the duty periods (16%) ranged from 8.5 to 18 h duration.





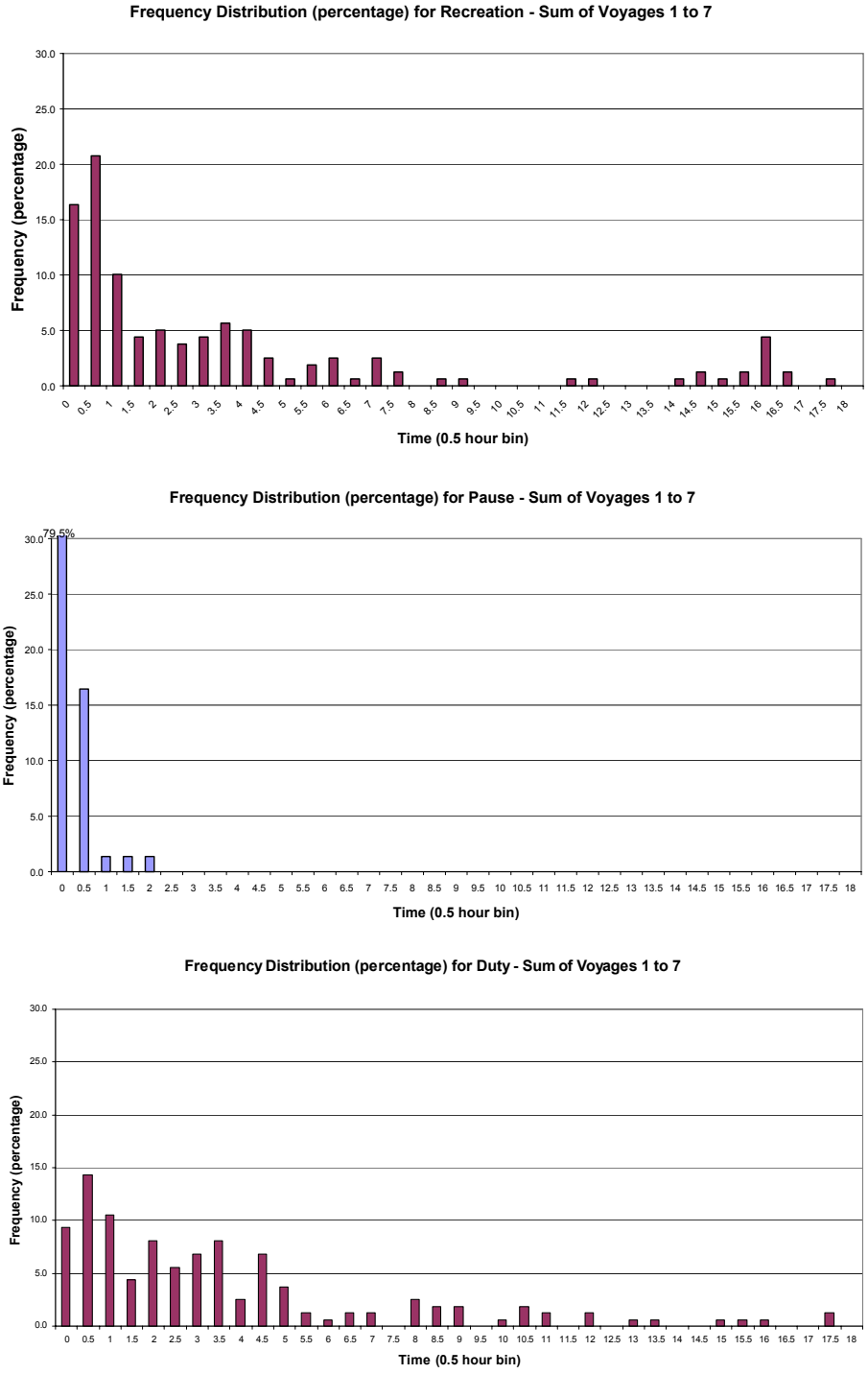


Figure 4.1. Distribution of durations by activity (from top to bottom, page 20: Sleep, Nap; page 21: Recreation, Pause and Duty).

Table 4.8 shows the mean time spent on each activity during each day logged by the respondents. These values are higher than the mean durations shown in Table 4.7 because most days included more than one period of any given activity (except sleep for which there was mostly one period each day). For the seven voyages considered separately, time spent on sleep did not vary greatly. All respondents spent an average of at least 6 h sleeping. Time spent on duty was much more variable, presumably reflecting ice conditions during the voyage. These variations were balanced by time spent on recreation. Increased duty time resulted in less recreation time, not less sleep.

Voyage	Activity (hours:minutes)				
	sleep	nap	recreation	pause	duty
1	6:59	0:29	7:49	0:32	8:10
2	5:59	0:41	0:52	1:19	15:09
3	7:16	0:22	7:58	0:23	8:01
4	7:03	0:04	13:05	0:00	3:48
5	6:11	0:51	2:17	1:30	13:11
6	6:44	0:33	10:25	0:01	6:17
7	7:06	0:11	10:33	0:00	6:09
Overall Mean	6:46	0:31	7:41	0:27	8:34

Table 4.8: Mean time in each activity per day

4.3.3. Self-ratings of fatigue

The respondents made 542 self-ratings on the tired/wakeful scale. (The number of ratings differed from the number of periods because some ratings were made in mid-period. In addition, ratings were not made at the end of every period.) Each self-rating was quantified by measuring the distance between the inserted mark and the left boundary of the scale. This gave a value lying between zero and 52 (the length of the scale in millimetres) with a higher value representing a higher rating of wakefulness as against tiredness. Table 4.9 shows the millimetre-values distributed in terms of four segments of the scale corresponding to very tired-tired, tired-borderline, borderline-wakeful, and wakeful-very wakeful.

Voyage	Less Wakeful	Rating Value Category (mm)			More Wakeful
	00-13	14-26	27-39	40-52	Total
1	4	2	39	62	107
2	0	0	22	53	75
3	0	5	19	73	97
4	0	1	15	23	39
5	0	0	24	68	92
6	3	9	11	69	92
7	1	4	13	22	40
Total	**8**	**21**	**142**	**370**	**542**

Table 4.9: Distribution of tired/wakeful ratings

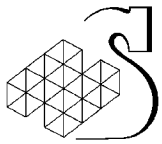
About two-thirds of the ratings (68 percent) were in the fourth segment showing that the respondents most often rated themselves as wakeful-very wakeful. In fact, even within that category the ratings tended to be in the upper part. About one quarter (26 percent) of the ratings were in the borderline-wakeful category and only 6 percent were in the very tired-tired and the tired-borderline categories. This distribution pattern was found in all seven voyages.

Table 4.10 shows the mean and median ratings at the conclusion of each category of activity. (In view of the possible confusion between recreation and pauses noted above, data for those two categories were combined.) Overall, respondents rated themselves more wakeful at the end of the sleep and nap periods and more tired at the end of the recreation/pause and duty periods. This was generally true for each voyage considered separately. This result was to be expected and in some measures validates the rating technique.

Voyage	Mean Activity Rating (median value in brackets)			
	Sleep	Nap	Recrtn/pause	Duty
1	44 (47)	42 (45)	38 (40)	38 (40)
2	49 (50)	50 (50)	41 (41)	40 (38)
3	46 (45)	43 (46)	41 (43)	43 (46)
4	50 (51)	50 (50)	37 (36)	36 (38)
5	49 (50)	48 (48)	41 (41)	41 (41)
6	44 (44)	38 (40)	38 (44)	42 (46)
7	47 (50)	36 (47)	37 (35)	29 (33)
Mean	47 (48)	44 (46)	39 (40)	38 (40)

Note: Entries are millimetre-values.

Table 4.10: Tired/wakeful rating at the end of each activity



4.3.4. Time of day

The Arctic waters of interest in this study extend over four time zones, from Atlantic Standard Time (UT-4) in the east to Pacific Standard Time (UT-7) in the west. The Fednav reports showed that for the four voyages in question, ship time was usually set to Eastern Standard Time (UT-5), although Atlantic Standard Time was used on some days in more easterly waters.

In respect of time of day, the instructions for completing the sleep/activity log were deficient in not specifying which time zone to use in recording times or, alternatively, asking the respondent to record which time zone he had used. It was clear from the Fednav reports that one respondent had used ship time, while it was clear from the logs that one respondent had used UT. It was not possible to clarify the situation in those voyages for which there was no supplementary information, and so the data of only four voyages were used in analyzing the effects of time of day.

For consistency in data collation, all times were recorded as UT-5 for analysis, and the data were corrected where necessary. Furthermore, in view of the small number of data in some categories, the data of all four voyages were pooled to create a single data set.

Table 4.11 shows the numbers, means and medians of the ratings made in each four-hour segment of the day categorized by activity. There were relatively few sleep and nap periods and most ended in one segment: the 0400-0759 segment for sleep periods and the 1200-1559 segment for naps. There were more recreation/pause and duty periods and ratings for those periods were distributed more evenly throughout the day. Figure 4.2 shows that for the two activities with the larger and more evenly distributed numbers of cases (recreation/pause and duty), there was a classic time-of-day effect, with higher wakefulness occurring before midday.

Time Segment	Mean Activity Rating (median value in brackets)							
	Sleep		Nap		Recrtn/pause		Duty	
	n	mean	n	mean	n	mean	n	mean
0000-0359	5	45 (47)	0	-	5	26 (34)	3	33 (45)
0400-0759	34	47 (48)	1	36 (36)	26	45 (47)	14	39 (45)
0800-1159	7	45 (46)	1	34 (34)	27	43 (45)	31	43 (47)
1200-1559	2	42 (42)	8	43 (42)	25	38 (43)	25	40 (44)
1600-1959	0	-	1	50 (50)	31	41 (43)	28	42 (44)
2000-2359	4	40 (46)	2	39 (30)	39	32 (32)	13	35 (36)
Total	**52**		**13**		**152**		**114**	

Note: Entries are millimetre-values.

Table 4.11: Tired/wakeful rating at the end of each activity categorized by time of day

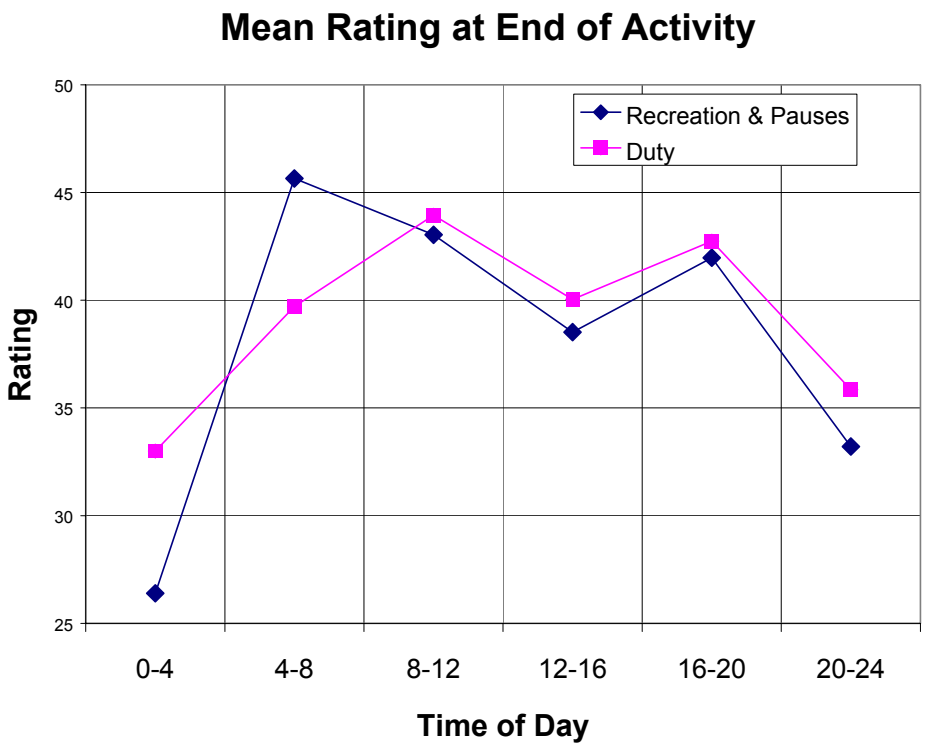


Figure 4.2. Mean ratings for recreation/pause and duty periods plotted against time of day

While the data of Table 4.11 show a time-of-day effect for all voyages, a more detailed consideration of circadian rhythm requires inspection of individual data on a day-to-day basis. Figure 4.3 shows the results of an analysis of the data of Voyage 5 from this point of view, using certain criteria derived from the examination of Figure 4.1.

The periods plotted in Figure 4.3 as duty periods included all periods recorded as such in the log together with all pauses and those recreation periods of 2 h and less that were bordered by duty periods. (In other words, if a pause or short recreation period occurred in the middle of a duty period it was regarded, for this purpose, as part of that duty period.) The periods plotted as rest periods included all sleep periods and naps, all recreation periods exceeding 2 h, and all recreation periods regardless of length that were followed by a sleep period or a nap.

In Figure 4.3, the periods of both kinds are plotted continuously against time of day in 24 h segments. If a period extended beyond 2400 the extension is shown extending beyond the end of the day in question and then completely shown again before the beginning of the next day. In other words, the periods shown in Day (D+1) are shown again in Day (D-1).

Figure 4.3 shows that on most days the respondent was on duty during a day shift extending approximately from 0900 hours to 1800 hours and a night shift extending approximately from 2000 hours to 0400 hours. Between the two shifts in a given 24 h period, the respondent took rest and often slept in both rest periods, although sometimes sleep took the form of a nap. The pattern was disrupted to some extent while the ship was in port on Days 6, 7 and 8, but in general it seems reasonable to conclude that the respondent followed a bi-phasic day.

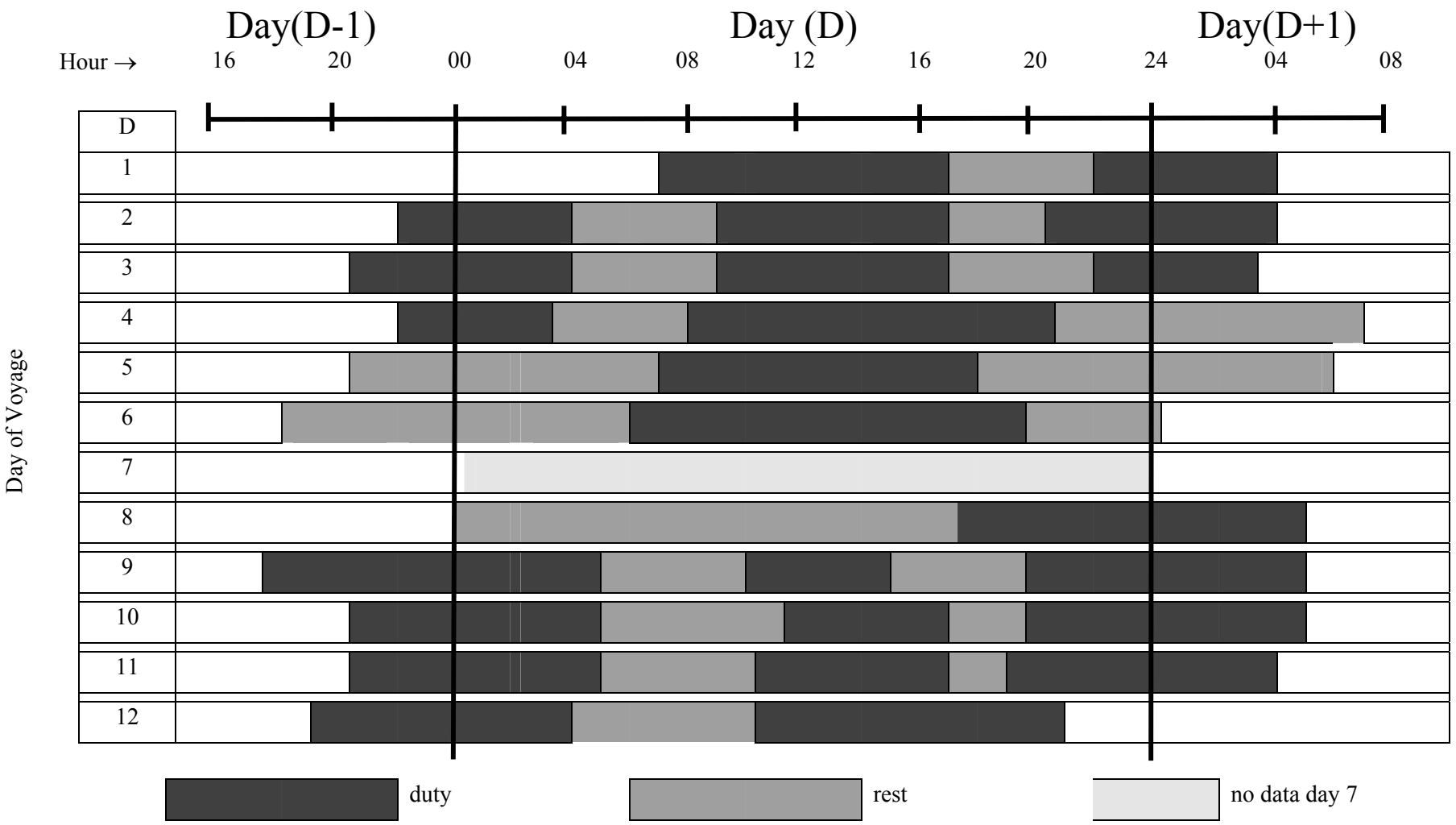
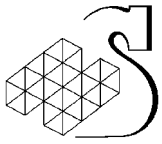


Figure 4.3 – Schedule of duty and rest for Voyage 5

Note: For further explanation see text.



4.3.5. Critical incidents of fatigue

Table 4.9 shows that on three voyages respondents recorded eight ratings in the range very tired-tired. These occurred in four incidents. Some (but not necessarily all) relevant details of these incidents are given here. In at least two of these incidents the ship was under escort by an icebreaker.

In Incident 1, the respondent started duty at 1555 hours following a nap and recreation period of 4 h. He then remained on duty until 1530 hours the next day with only three pauses of 25 min, 15 min and 35 min duration at 1800 hours, 0745 hours and 0820 hours. Thus, he was on duty for 22 h 10 min in a period lasting 23 h 25 min. At the end of that period he rated himself as very tired (06 on the 52-mm scale) He then took 20 min recreation, at the end of which he made the same rating before sleeping.

In Incident 2, the respondent started duty at 0140 hours following a sleep and recreation period of 3 h 10 min. He then remained on duty until 0440 hours, took a 140 min break that included a 20 min nap, returned to duty for 10 min until taking a 45 min pause, and then remained on duty until midnight that day. Thus he was on duty for 19 h 5 min in a period lasting 22 h 20 min. At the end of that period he rated himself as very tired (04) He then took a 2 h recreation period, at the end of which he made a slightly lower rating (03) before sleeping.

In Incident 3, the respondent started duty at 1020 hours following a sleep and recreation period of 6 h 15 min. He then remained on duty until 0215 hours the next day, a period of 15 h 55 min without a break at the end of which he rated himself as tired (25). Following a 1 h recreation period he rated himself as very tired (02) and then slept. He returned to duty at 1225 hours and remained on duty until 1745 hours, taking a 1 h recreation period at 1615 hours. Thus he was on duty for 21 h 15 min in a period lasting 31 h 25 min. At 1745 hours he rated himself as tired (13) and after taking a 20 min recreation period he rated himself as very tired (04). The respondent then took a nap of 1 h 10 min and on returning to duty at 2345 hours rated himself as wakeful (46).

In Incident 4, the respondent started duty at midnight following a sleep and recreation period of 3 h 5 min. He then remained on duty until 1540 hours, taking a 50-min nap at 1040 hours. Thus, he was on duty for 14 h 50 min in a period lasting 15 h 40 min. At 1540 hours he rated himself very tired (06) and slept.

Table 4.12 shows the salient features of these four incidents. Three of the five ratings occurred in the 0000-0359 segment of Table 4.11 when mean post-duty rating was lowest.

Incident	Period		duration		rating value (and time of rating)		
	start	end	full	duty			
1	1555	1530	23:25	22:10	06 (1530)	06 (1550)	
2	0140	2400	22:20	19:05	04 (2400)	03 (0200)	
3	1020	1745	31:25	21:15	02 (0315)	13 (1745)	04 (1805)
4	0000	1540	15:40	14:50	06 (1540)		

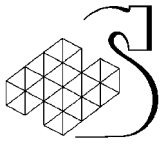
Table 4.12: Synopsis of critical incidents

4.3.6. Supplementary data

In addition to the data about work scheduling directly requested in the logs, respondents wrote in the logs (and in the reports prepared for Fednav International Ltd.) supplementary information about the voyages in question.

These comments emphasized how duty requirements varied with ice conditions and with the level of involvement of the Master, and how rapidly ice conditions changed due to wind action. In this season, for some voyages at any rate, ice conditions were very good with pack ice found only further west. With an active Master it was only in those conditions (and when the ship was under escort) that the ice navigator had to hold the con and extended duty might be required. Under those circumstances, duty was very intense with meals (and pauses for personal needs) taken while holding the con.

At other times the ice navigator was required only to provide advice and not to hold the con. Outside the Shipping Safety Control Zones (and while the ship was in the Arctic port) the ice navigator was essentially a passenger.



5. Discussion & Conclusions

5.1. Evaluation of method

The investigators collected data by two techniques:

- (1) focus group interviews and discussions based on prepared questionnaire forms, and
- (2) duty/rest logs used to record hours of duty and rest.

5.1.1. Questionnaire form

The investigators prepared the questionnaire form with two objectives in mind: to provide structure for group interviews where participants were able to attend focus groups and to collect data from participants by mail or by telephone where personal attendance was not possible. All participants were able to attend group interviews in person and the forms were not used for the second purpose.

As far as providing a structure to the interviews was concerned, the questionnaire form was very effective. The participants were able to answer most if not all of the questions and they were encouraged to add a considerable amount of verbal comment to their written responses. The data thus had more structure than if they had been asked for verbal comment alone, and more detail and depth than if they had provided written comments alone.

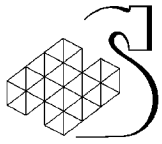
Each of the two focus group interviews lasted a little more than two hours, indicating that the questionnaire form was also of a satisfactory length. Some questions (relating to average hours of duty, for example) may have been better worded, but in the context of holding an interview deficient wording was easily corrected and the deficiency served in any case to highlight the point that the participants wished to make. Similarly, although participants were quick to point out that the M.V. Arctic was an inappropriate model for describing the task of ice navigators on ships of a low icebreaking class, it served to provoke them into specifying the differences.

The question based on the maps may have been rather ambitious in scope in that it required more time than the investigators anticipated for making an adequate response. Participants said that completing the map accurately depended too much on their memory of the voyages and required too much time to complete.

In sum, the investigators collected valid information about the task and scheduling of ice navigation from experienced and articulate ice navigators. This provided the project with a sound basis for useful findings.

5.1.2. Duty/rest log

The investigators prepared the duty/rest log with the objective of collecting data relating to the actual work schedules of ice navigators by a relatively non-obtrusive means. They promoted use of the log by fostering a rapport with the participants at the focus group interviews and by mailing reminders to them after the interviews. The outcome indicates that they were reasonably successful in meeting this objective. Three of the original seven ice navigators participating in the interviews returned



completed logs at the end of the summer season. Discounting the participant who was not an ice navigator on foreign-registered ships, this represents a very satisfactory response rate of 50 percent.

5.1.2.1. Validity of the data

The records of dates and times were partially checked for validity by comparing them with data from the reports provided by Fednav International Ltd.. This comparison showed that where both sources of data were available, the respondents had reliably recorded their activities.

As far as the ratings were concerned, all respondents used the rating scale in a systematic and valid manner. Mean ratings were lower after duty and extended recreation and higher after sleep and naps (Table 4.10). While most ratings were in the upper parts of the scale, indicating that respondents were generally wakeful, some were at the very low end (Table 4.9). The scale had thus provided a means for respondents to record their fatigue when such a condition actually arose.

5.1.2.2. Definitions of activities

The definition of duty as time spent working was, perhaps, too broad. Standing on the bridge holding responsibility for the con of the ship was quite different from the task of sitting in a cabin doing paperwork. Doing paperwork was probably no more fatiguing than passing a recreation period in reading a novel, for example. Put another way, even recreation is fatiguing and probably as much so as filling in a log. The real focus of interest of the study was on fatigue arising from being on the bridge. It might have been more pertinent, therefore, to have defined duty as holding the con, or at least as being present on the bridge. Conversely, it might have been reasonable to consider paperwork equivalent to recreation.

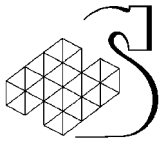
In other respects, however, the definitions appeared to reflect the actual situation on board. The distributions of the durations of each activity show that pauses were correctly recorded as periods not on active duty, and like naps, they were recognized as being of short duration. Respondents were able to distinguish naps from periods of sleep.

5.1.2.3. Time zones

The investigators did not sufficiently consider passage through time zones and the clock time followed on board ship. This point was important in terms of correctly interpreting the recorded data as well as being of interest. Fortunately, the oversight was corrected by at least one of the respondents and the Fednav reports also allowed the point to be corrected. In general, however, the duty/rest log had been well designed as a method of data collection, and the investigators could confidently accept the validity of the data.

5.2. Interpretation of results

The data analysis was based on a total of seven voyages. Each voyage was treated as if it were an independent occurrence with no account taken of between- or within-respondent differences. In these circumstances no test of statistical significance was applied to the data. Nevertheless, the study provided sound information about ice navigation and the work scheduling of ice navigators on board foreign-registered ships in Canadian Arctic waters.



5.2.1. The task of ice navigation

The ice navigator's task is to guide the ship while it is in the Shipping Safety Control Zones by the most effective path to its destination, considering all circumstances, in particular the need to avoid contact with ice. This required various data sources to be evaluated and assessed and the results communicated with other personnel. The ice navigator provides guidance at a tactical level by assuming responsibility for the con of the ship and, at a strategic level, by advising the Master and the Officer On Watch of preferred routes. The consequence of poor task performance is, at best, for the ship to follow a less efficient path and, at worst, for it to collide with ice.

In information-processing terms, the task requires acute perceptual judgment, careful decision-making and critical choice for action. The task also requires constant vigilance, giving the ice navigator an intrinsically heavy workload. The consequences of poor performance are potentially catastrophic and this constant awareness of hazard adds to the ice navigator's workload.

The ice navigator performs the task by virtue of perceptual, cognitive and motor skills acquired over years of experience. Performance outcomes are, however, determined not only by the ice navigator's skill but also environmental, workplace and work scheduling factors.

5.2.1.1. Environmental conditions

Ice navigation is more difficult when ice, weather and sea conditions are bad. Rapid changes in ice conditions due to changes in weather add more difficulty to the task. However, this is of the nature of the task and cannot be directly altered. However, it may be possible to alleviate their effects by providing more accurate or more timely information that would, for example, enable the ice navigator to choose routes that avoid the worst conditions.

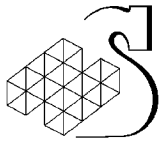
Work could be done through the Canadian Marine Advisory Council (CMAC) process for the Canadian Ice Service of Environment Canada to examine ice products and their ability to tailor ice Analysis Charts to specific ship operations or other areas of interest in varying degrees of detail. A wide array of possibilities exists to service the marine client now that Radarsat is fully operational and communication methods are continually improving.

5.2.1.2. Workplace design

Ice navigation, like any task, is more difficult to perform in a badly-designed workplace. In this respect the interview participants mentioned particularly that they had to stand for long periods (Table 4.4) and that they experienced the desire to sit or lie down and developed sore muscles (Table 4.5). Standing is not an intrinsic feature of the task of ice navigation but relates directly to workplace design. In a similar vein, the participants mentioned visibility from the bridge as being poor at times (Table 4.1).

Closely related to the physical aspect of workplace design is the organizational aspect. Participants mentioned inexperience of ice navigation among, and difficulties of communication with, other bridge officers as sources of increased workload (Tables 4.1 and 4.2).

In the context of ice navigation on foreign-registered ships, workplace design requires an international rather than a Canadian response. At this point it is sufficient to note the problem.



5.2.1.3. Work scheduling

The interview participants reported that they did not follow basic watchkeeping schedules but were on call, and often on duty, for long and irregular periods. They mostly stated that they had sufficient sleep but nevertheless commented on its irregularity and noted the workload associated with the long duty periods that sometimes elapsed before they could sleep (Table 4.3). The duty/rest log data provided a clearer account of the situation.

On average (and with pauses included as duty) the respondents were on duty for just over 9 h on each day of the voyage (Table 4.8). This left an average rest period of a little under 15 h of which a little over seven hours was taken in sleep or as a nap, although not always as a single uninterrupted period. These figures present a satisfactory situation in terms of the maximum hours of work and minimum hours of rest suggested by the research literature as being necessary for efficient and accurate performance.

However, these figures mask the extreme situations. The distribution of durations of duty periods shows that several duty periods were prolonged beyond 12 h duration (Figure 4.1). (This distribution did not take account of pauses. If pauses are included as duty the number of periods exceeding 12 h is greater.)

Conversely, the distribution of sleep periods shows that only 45 percent of a total of about one hundred sleep periods exceeded six hours in duration. Thus although mean total sleep may have been adequate, there were many days on the voyages when the respondents did not take as much as 6 h of continuous sleep. (However, this distribution did not take account of recreation periods. If recreation is included as rest the number of rest periods exceeding 6 h is greater.)

Figure 4.3 shows the details of an individual situation. On at least five days of the twelve-day voyage, the respondent had no sleep period exceeding six hours. More interestingly, the respondent adopted a bi-phasic day by sleeping in two relatively short periods during each 24 h day, with each sleep period separated by a period on duty. This schedule resembled a standard watchkeeping schedule of 6 h on/6 h off.

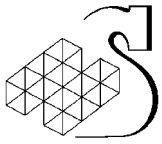
5.3. Application of findings

This study addressed the question of subjective fatigue in ice navigators in general terms in the interviews and in specific terms in the duty/rest logs. The question is of interest because subjective experiences of fatigue correlate with objective incidents of unsafe performance, i.e., ice navigators are liable to make performance errors when they feel fatigued.

5.3.1. Assessing fatigue

While only three interview participants assessed fatigue as a problem that was moderately serious for ice navigators, with four stating that it was hardly serious at all, no participant stated that the problem of fatigue for ice navigators was not at all serious. Every participant attached some degree of seriousness to it even while stating that it was limited in extent.

The same picture emerged from the log data: on most occasions respondents rated themselves between wakeful and very wakeful, or at least between borderline and wakeful, but there were a few occasions when they acknowledged that they were very tired. Thus fatigue among ice navigators can be regarded (as they themselves stated) as an acute rather than a chronic problem. They do not



continually feel themselves to be fatigued but they *can* feel fatigued and on occasions *do*. When they do it may have serious consequences.

Since fatigue is not a chronic problem, the effect on ice navigator performance can be expected to be generally low. As an acute problem, however, fatigue can potentially contribute to critical incidents that may result in accidents. Industrial accidents occur because of a chance juxtaposition of multiple single events that would not result in an accident result in an accident if each event occurred in isolation. Acute fatigue is such a factor: it does not of itself cause an accident, but it contributes to the complexity of events that occasionally does cause an accident.

The log data reveal at least four critical incidents of acute fatigue that, because other events were fortunately not coincident, did not have an accident as an outcome. Such is most often the case, but it would clearly be prudent to reduce the probability of such a situation occurring, and hence of an accident occurring, by reducing the occurrence of acute fatigue.

5.3.2. Alleviating acute fatigue

5.3.2.1. Role of work schedules

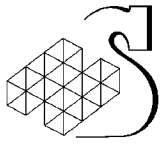
Work schedules can be designed (1) to reduce the incidence of avoidable fatigue and (2) to have work done at times other than when fatigue cannot be avoided. Research shows that this can be done by taking account of duration of work, duration of rest and the time of day at which work is done and rest is taken. The results of the present study confirm these findings.

Fatigue (as measured by lower self-ratings) was greater at the end of periods of duty and recreation compared to the end of periods of sleep and naps (Table 4.10). As far as duty is concerned this is a result of doing work, and as far as recreation is concerned it reflects unavoidable fatigue as a result of being awake for a long period occupied in exercise or other activities. More significantly, fatigue at the end of duty and recreation was related to time of day (Table 4.11, Figure 4.2).

The participants recognized the role of work scheduling in producing fatigue by proposing (as a solution to the problem of fatigue) that the ship should carry sufficient qualified personnel to allow them to follow suitable watchkeeping schedules. They also mentioned work scheduling as one of the questions discussed with the Master on joining the ship. The data shown in Figure 4.3 suggest that a schedule of a kind might be followed, possibly without explicit intention. Thus although participants stated that they did not follow fixed schedules because they could not do so, the situation may have been more structured than that statement implied.

5.3.2.2.Current regulation of work schedules

Shipping employees are subject to regulations that to some degree impose work schedules on them. These regulations (the proposed *CRs* and the actual *SMRs*) impose (1) hours of rest of minimal duration (not less than six consecutive hours of rest in every 24 h period and at least 16 hours of rest in every 48 h period) and (2) periods of rest of minimal separation (not more than 18 h and not less than 6 h between the end of a period of rest and the beginning of the next period of rest) (Canada Gazette 1997, Sections 13(2) and (3)).



The sleep and recreation categories defined in the duty/rest log together represent rest as defined in the regulations. That being the case, Table 4.8 indicates that, on average at least, the respondents observed the regulations in some respects, although as ice navigators they were not required to do so. At the same time, Table 4.7 indicates that they did not observe them at all times. These include times when critical incidents of acute fatigue occurred (Table 4.12). Furthermore, Figure 4.3 indicates that at least one respondent did not observe the regulations with respect to consecutive hours of rest.

To the extent that the ice navigators choose to conform to statutory regulations, it may be concluded that existing regulations do, to some degree, impose work schedules on them, and that the respondents did, to some degree, observe them. At the same time, the results of past and present studies show that the regulations are deficient in the manner in which they do this. This is primarily because they do not take account of time of day. For the purpose of alleviating fatigue, regulating time of day at which work is done and rest is taken is more important than regulating duration of work and duration of rest.

The presumption that recovery from fatigue is directly proportional to the amount of rest taken is invalidated by the observation that performance deteriorates at certain times of day regardless of the duration of work or rest and by the finding that short naps (irrespective of their length) serve to alleviate fatigue and inattentiveness. Consequently, the approach that addresses hours of rest, hours of work and time of day in that order of priority is flawed. In fact, virtually all research workers in the field support an approach that addresses these factors in the order time of day, hours of work and hours of rest. This is the approach advocated here.

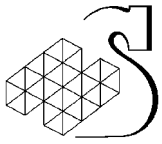
5.3.2.3. Proposed regulation of work schedules

The previous report prepared by Human*systems* Incorporated recommended adopting regulations that would require watchkeepers to follow duty schedules based upon clear criteria, among which was the use of a 24 h day (Buck et al. 1995, Section 6.3). The results of the present study confirm the validity of that recommendation.

In formulating the recommendation, general operational practices in the shipping industry were taken into account in order to make the proposed regulation operationally feasible. Operational practices related to Arctic shipping, as revealed in the present study, confirm the practicability of the recommendation in all except perhaps one respect. The exception relates to the requirement for uninterrupted rest.

Regarding interruption of rest, the regulations require not less than six consecutive hours of rest in any one period of 24 h. (The recommendation retained this requirement.) For Arctic shipping this requirement may conceivably be too stringent. (Even for other sectors of the industry it allows very little flexibility when watchkeeping schedules of 6 h on/6 h off are followed.) Furthermore, from the point of view of research into napping, it may be unnecessarily stringent.

The log data suggest that ice navigators may already adopt 24 h based work schedules, even though they may have not clearly recognized this. Thus, although ice navigators may not be required to observe the regulations, the recommendations that they should follow duty schedules based on the use of a 24 h day would not be impossible to observe.



Finally, regarding time zone change the data suggest that ship time often remained fixed even though the ship was moving across standard time zones. At Arctic latitudes time zones are relatively narrow in width and such a practice is, for this if for no other reason, not unexpected. From the point of view of work scheduling the practice is particularly desirable (and for that reason forms part of the recommendation). Thus even though ship time as determined by the Master may change, it is recommended that it remain unchanged for the purpose of setting hours of duty and hours of rest while the ship is in the Shipping Safety Control Zones.

5.4. Future work

5.4.1. Data collection techniques

The technique of collecting data directly from ice navigators has an obvious validity. As far as assessing subjective tiredness is concerned, it is in fact the only technique available. At the same time, fatigue can be assessed by other methods ranging from analyses of video recordings of ice navigator's demeanours, to analyses of actigraph (sleep recording device) data and analyses of physiological indices such as electroencephalographic and electroocular recordings.

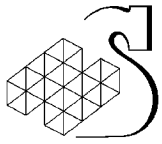
Fatigue can also be measured indirectly by evaluating performance, on the basic assumption stated above, that fatigue is associated with degraded performance. This technique brings the issue back to the fundamental aim of the research, that of eliminating accidents. Ultimately, the aim is to relate work/rest scheduling (and any other chosen operational factor) to performance in order to reduce the incidence of inadequate performance. If degraded performance is used as an index of fatigue, degraded performance can be related directly to the operational factor of interest (in this case work/rest scheduling) without introducing fatigue as an intervening variable.

While this approach is straightforward in concept, performance evaluation is not necessarily simple in application. Ice navigation is a complex task, the outcome of which does not easily resolve itself into judgments of correct and incorrect (or even of more correct and less incorrect) performance. However, the problem is not insoluble in principle. Furthermore, performance evaluations may already be on record. Apart from evaluations done for managerial purposes (for purposes of promotion and salary awards, for example) performance evaluations are made whenever shipping occurrences are reported to the Transportation Safety Board of Canada. The reports of the Board thus provide a potentially rich source of performance data.

Finally, for the sake of a comprehensive review, the supplementary-task technique may be considered. In this technique operators (ice navigators) perform a secondary (but non-intrusive) task during the course of performing the primary task (Ice Navigating). Data from the secondary task then provide an index of concomitant performance on the primary task.

5.4.2. Task analysis

Ice navigating is, in itself, a stressful and fatiguing task. ice navigators become tired while performing their task irrespective of other factors (such as scheduling practices) that may exacerbate that tiredness. This point has been made in interpreting the results of the present study by drawing attention to environmental conditions (ice, sea and weather conditions among others) and workplace design (bridge design and communication problems, for example) as factors contributing to fatigue. In addressing this issue of the inherent stress of Ice Navigating, it is necessary to recognize that Ice Navigating is a complex task that includes many elements, some of which may be more stressful than



others. For example, Ice Navigating in convoy was identified by participants as being particularly demanding. It is pertinent to consider, therefore, which elements of Ice Navigating are more likely than others to generate fatigue.

Apart from their potential for generating fatigue, some elements of Ice Navigating may be more sensitive to fatigue than others and as such have a greater potential for producing a catastrophic outcome. Again, Ice Navigating in convoy was identified by participants as a hazardous situation with a greater risk of a critical incident developing. The problem can in fact by compounded: the situation generates fatigue (partly because of its hazardous nature); the fatigue makes it more difficult for the ice navigator to perform at the required level of competence, and this in turn increases the inherent risk in the situation.

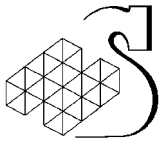
These considerations point to the need for carrying out a full analysis of the task of Ice Navigating. An analysis of this kind would play a role in identifying task elements particularly sensitive to fatigue (and to the effects of poor work/rest schedules). Furthermore, it would address issues of how poor task design may contribute to poor performance irrespective of the role of fatigue. For example, poorly-designed instruments may contribute to fatigue on the part of ice navigators who must rely on them for critical information, but then may produce poor information anyway. In other words, ice navigators using poorly-designed instruments are liable to make errors whether they are tired or not.

With this approach, degraded performance and the role played by fatigue in producing degraded performance can be evaluated in a full and comprehensive context. Task analyses are based upon conceptual models that include information-processing, resource-allocation and operator-process models as discussed by Buck and Webb (1992). This latter report, together with other reports prepared by Human*systems* Incorporated (Buck et al. 1995, Webb and Greenley 1993) including the present report, provide, moreover, an initial source of data for the task analysis. Further data could be obtained by interviews with ice navigators (and possibly, as discussed in Section 5.4.3, other pilots) and by sea-going observations if that were feasible.

The analysis can be supported by computer-based tools that permit predictive simulations of ice navigator performance (Laugherty and Corker (1997), Beevis (1992)). A variety of human performance modeling packages are available. They contain models of human performance which allow predictions of levels of operator fatigue and workload, and probability of task completion using different environmental conditions and operator characteristics. This permits analysis of different work schedules, working conditions (e.g. ice conditions), bridge layouts, etc. to optimize operator performance.

5.4.3. Other pilotage operations

Ice Navigating is a task with its own special characteristics calling for its own special skills. It is clear, however, that Ice Navigating can be categorized with other tasks that share common characteristics. It can be described, for example, as the task of conning the ship in ice-infested waters. More generally, it possesses many of the characteristics of general piloting. For example, the communication problems cited by the participants of the present study, and the need for establishing rapport in a relatively transient working group, are issues for all pilots, not just ice navigators. At an even more general level, Ice Navigating shares some of the characteristics of all bridge tasks and of shipping operations as a whole.

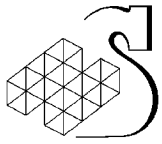


The present study addressed problems associated with ice navigators working on foreign-registered ships in Canadian waters, and as such was limited in scope by the relatively small number of such personnel. To the extent that Ice Navigating shares salient characteristics with piloting and other conning tasks, the population of interest can be increased in number and the scope of any future study can be extended.

5.4.4. Specific proposals for future work

In the light of the foregoing discussion, some specific proposals for future work may be formulated.

- Evaluate fatigue among ice navigators through field study using tools such as video recordings taken on the bridge and actigraphs.
- Review occurrence reports prepared by the Transportation Safety Board of Canada.
- Prepare a task analysis of Ice Navigating using computer–based task modeling tools to predict human performance under different operating conditions.
- Repeat the present study, and extend the proposed studies, to include pilots other than ice navigators.
- Investigate ice navigator training and certification program(s) focusing on fundamental ice navigator skills and how they are taught.
- Continue to review current regulations with particular reference to a) their concordance with other regulations such as the STCW and b) the desirability to allow for the practice of napping.



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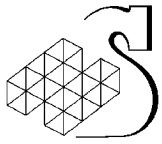

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Annex A

English and French versions of questionnaire

Ice Navigator Duty/Rest Questionnaire

This Questionnaire intends to gather information about fatigue among ***Canadian ice navigators On Board Foreign-registered Ships In Canadian Arctic Waters.*** The ultimate intention is to improve marine traffic safety in northern waters by alleviating sources of fatigue. This study is sponsored by the Transportation Development Centre of Transport Canada (TDC).

Human*systems* Incorporated has been contracted by TDC to carry out the study. We are an independent Human Factors and Ergonomics company and any information you provide will be kept confidential. Only summary data will be used in reports.

We are using two methods to gather information.

1. **Questionnaire**
   The questionnaire has 5 sections:

   1) general conditions of employment,
   2) ice navigator's tasks and duties,
   3) working conditions,
   4) work schedules, and
   5) fatigue.

2. **Duty/Rest Log**
   A diary of your daily duties and rest while on your voyages this season.

Instructions for completing the questionnaire:

In the meeting today, we will go through the five sections one at a time.

When we have explained what we are asking, please write your answers down on the sheets provided. If you need more space, write on the back of the page or we can give you additional sheets. (Please put your name or initials on every sheet).

In answering these questions, refer to your experiences during the 1996 season or, if you were retired before then, to the last full season in which you worked.

When everyone has completed the first section we will have a general discussion and go on to the second and so proceed through all five. Don't hesitate to ask questions at any time.

When all five sections have been completed will have a general discussion. If you have nothing more to add, we will ask you to put your questionnaire into the envelope, seal it, and hand it to the Human*systems* consultant.

If you subsequently remember something else that you think we should know please call, fax or write us directly at (collect calls will be taken by Jeremy Brooks):

Human*systems* Inc. phone (519) 836-5911
111 Farquhar St. fax (519) 836-1722
Guelph, Ontario, N1 h 3N4

1.0. General conditions of employment

1.1 a) Number of years experience working as an ice navigator on **foreign-registered ships in Canadian Arctic waters** (not including 1997): _____ years

1.1 b) Total number of voyages (approximately): _____ voyages

1.1 c) Your age: _____ years

1.2 What was your maritime experience prior to Ice Navigating on **foreign-registered ships in Canadian Arctic waters**? (For example, were you a Master for 2 years or a first mate for 7 years, were you on icebreakers, were you in the Canadian Arctic)?

Position	Years Experience	Types of vessels	Location of Voyage	Time in Ice Intensive Waters (%)

Use the table below to answer the next 3 questions concerning up to the last 4 seasons in which you were performing ice navigation duties on **foreign-registered ships in Canadian Arctic waters**.

1.3 When did the season begin and end?

1.4 How many voyages did you make during the season?

1.5 Did you ever have to perform other duties (in addition to Ice Navigating)? Yes ❑ No ❑
If Yes, what were they and what proportion of your time was taken up by these other duties?

Year (or last four years employed)	Season Duration		Number of Voyages	Other duties and proportion of work (%)
	beginning month	end month		
96				
95				
94				
93				

We would like to gain insight into the general regions of travel which may affect your working conditions and level of fatigue while on duty.

1.6 Please use the maps provided to describe 5 voyages that you feel will give us a cross section of your voyages by writing the following information on each map (1 map for each voyage)

A. name of the ship and port of registration

B. ports of call during the voyage and approximate dates. (The first and last date should be the dates at which you joined and left the ship.)

C. route followed by the ship

D. zones through which the ship sailed which affected your working conditions and level of fatigue (a zone is an area where conditions were in some way distinctive), for example

- First-year pack ice in one zone and harder Multi-year ice in another,
- bad weather in one zone and good in another,
- shallow vs. deep water,
- under escort,
- poor vs. good visibility etc.

2. The ice navigator's task and duties

A description of the ice navigator's task as it was described to us by ice navigators on the M.V. Arctic follows below. Please read this carefully and then answer the questions following it.

On the M.V. Arctic, an ice navigator is on duty on the bridge at all times while the ship is in ice-intensive waters. One of these persons is the Master and the other a qualified officer, the two standing alternate watches, usually of 6 h on and 6 h off, to ensure continuous coverage. Each may perform other duties when not on watch as ice navigator.

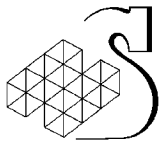
The task of the ice navigator is to navigate the ship, that is to set its course at a tactical level having regard to local ice, underwater, sea, traffic and weather conditions as well as to the strategic course set by the Master.

The ship encounters ice of a different nature in various parts of the Arctic. In the north, the ice is thick, hard, Multi-year ice moving south from the Arctic Ocean or else is first year ice formed during the previous winter. Further south, ice coverage is less extensive and gives way to icebergs, bergy bits and growlers forming discreet pieces of floating ice of decreasing size that present obstacles of a different kind.

In general, the ice navigator navigates the ship in order to stay in open water, avoiding ice while at the same time endeavoring to keep the ship to the prescribed course. If the ship encounters pack ice the ice navigator has the options of going around it, pushing through it, or ramming it in order to break it. For icebergs, the only option is to go around. The ice navigator must not only detect the presence of ice but also assess its nature and evaluate its strength. Various instruments aid him in doing this, but his interpretations of direct visual cues and vibratory cues (given by the ship when it hits the ice) remain important components of his skill.

The ice navigator does not normally steer the ship directly but gives instructions to the helmsman to do so although the ice navigator may control the engine himself. Thus while all persons on the bridge may assist the ice navigator in keeping a look-out, they all know which person has charge of navigation and who is responsible for instructing the helmsman. As ice navigators begin and end their periods of duty this responsibility is intentionally passed from one to another.

The task demands continuous attentiveness. The ice navigator must continually assess a constantly changing situation under varying conditions of visibility. To do this he must maintain appropriate look-out postures. These perceptual and postural aspects of the task are made more difficult by changing weather and sea states. ice navigators inevitably become more fatigued and their fatigue increases as the watch is prolonged. In addition, the watch must be maintained throughout a 24 h period including times when rest would normally be taken. When rest is taken, it may be disturbed by weather conditions, engine noise, ship motion, icebreaking and in other ways reduced in both quantity and quality.



2.1 Does the description on page 3 accurately and fully describe the work that you do on foreign-registered ships in northern waters? Yes ❑ No ❑

2.2 Is there any part of the description that needs to be modified? Yes ❑ No ❑

If Yes, please specify below **or** mark the text directly.

_____

_____

_____

_____

_____

2.3 Is there any part of the description that needs to be stressed? Yes ❑ No ❑

If Yes, please specify below or mark the text directly.

_____

_____

_____

_____

_____

2.4 Is there anything that needs adding to the description? Yes ❑ No ❑

If Yes, please specify.

_____

_____

_____

_____

_____

2.5 Is there any part of the description that does not apply to your work? Yes ❑ No ❑

If Yes, please specify.

_____

_____

_____

_____

3. Working Conditions

This section is divided into two general parts: working conditions and living conditions.

3.1 When working on a foreign-registered vessel what proportion of vessels fall into the following categories:

General Working Conditions				
Item on Foreign Registered Vessel	poor	satisfactory	good	Total
General cleanliness of the bridge				100%
General layout of the bridge				100%
Existence of suitable instruments and equipment				100%
Condition of relevant instruments and equipment				100%
Visibility through bridge windows (e.g. internal obstructions or ice build up etc.)				100%
Climate control on bridge (heating, ventilation etc.)				100%
Communications with the Master and other persons on the bridge				100%
Masters experience in Canadian Arctic waters				100%
other (please specify)				100%
other (please specify)				100%
other (please specify)				100%

3.3 If any conditions were ever rated as “poor” please describe the specific reasons that made them so.

_____

_____

_____

_____

_____

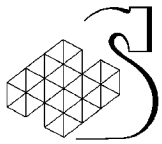
3.4 If any conditions were ever rated as “poor” did you feel that your work was seriously compromised because of this? Yes ❑ No ❑ If Yes, please describe why.

_____

_____

_____

_____



3.5 When working on a foreign-registered ship, what proportion of vessels fall into the following categories:

General Living Conditions				
Item on Foreign Registered Vessel	poor	satisfactory	good	Total
Food				100%
Communication with other members of the crew				100%
Sleeping accommodation				100%
Climate control (heating, ventilation etc.)				
other (please specify)				100%
other (please specify)				100%
other (please specify)				100%

3.6 If any conditions were ever rated as "poor" please describe the specific reasons that made them so.

_____

_____

_____

_____

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3.7 If any conditions were ever rated as "poor" did you feel that your work was seriously compromised because of this? Yes ❑ No ❑ If Yes, please describe why.

_____

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4. Work schedules

This section is divided into two general parts: theoretical schedule and actual working schedule.

4.1 In working as an ice navigator, did you theoretically follow a basic watchkeeping schedule?
Yes ❑ No ❑

If Yes, please answer the next two questions.

4.1 a) What was the schedule? (For example, was it 4 hours on 8 hours off, 6 hours on 6 hours off, or some other system?)

_____

_____

_____

_____

4.1 b) How closely did you actually follow the schedule? (please check one)

not at all ❑ hardly at all ❑ as often as not ❑ reasonably closely ❑ very closely ❑

For questions 4.2 to 4.6, ICE NAV duty + OTHER duty + SLEEP + all other activities = 24 hours

4.2 In actual practice, what were your average hours of duty on ice navigation each day?_____hours

4.3 If you ever had to do other duties, what were your average hours of duty on these other duties each day?_____hours

4.4 Out of these hours not on duty, what were your average hours of sleep each day?_____hours

4.5 Do you feel that you had enough hours of sleep on average? Yes ❑ No ❑

4.6 Do you feel that the sleep was of adequate quality? Yes ❑ No ❑

If No, please explain why not.

_____

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_____

5. Fatigue

5.1 Were there ever times when you felt that your work was seriously compromised by being too fatigued? Yes ❑ No ❑

If Yes, was this:

hardly ever ❑ seldom ❑ as often as not ❑ often ❑ very often ❑

5.2 Out of the possible reasons *relating to times of work and rest* that may have caused this fatigue, which of the following reasons apply to you:

Work and Rest	
1. Hours on duty were too long	❑
2. Hours of duty were too erratic	❑
3. Hours of rest immediately before duty were too short	❑
4. Hours of rest over several days were too short	❑
5. Hours of duty were very early in the morning	❑
6. Hours of duty were in the evening	❑
7. Hours of duty were at night	❑
8. There were too few opportunities for taking pauses	❑
9. There were too few opportunities for taking naps	❑
10. Hours of sleep were too short	❑
11. Sleep was too disturbed or of poor quality	
12. other (please specify)	❑

5.3 Out of the possible reasons *relating to workload* that may have caused this fatigue, which of the following reasons apply to you:

Workload	
12. Workload was too heavy because of ice conditions	❑
13. Workload was too heavy because of conditions of bad visibility	❑
14. Workload was too heavy because of conditions on the bridge	❑
15. Workload was too heavy because of difficulties with the Master or other members of the crew	❑
16. Workload was too heavy because of the need to stand for long periods	❑
17. Workload was too heavy because of other conditions…	❑
18. other (please specify)	❑
19. other (please specify)	❑

5.4 Did you ever experience any of the following symptoms of fatigue during a duty period?

Symptoms	Occurrence		
	never	occasionally	often
1. Forgetfulness	❑	❑	❑
2. Easily distracted	❑	❑	❑
3. Difficulty focusing attention	❑	❑	❑
4. Low motivation	❑	❑	❑
5. Did things at the wrong time	❑	❑	❑
6. Desire to sit or lay down	❑	❑	❑
7. Sore muscles	❑	❑	❑
8. Heavy eyelids	❑	❑	❑
9. Clumsy	❑	❑	❑
10. other (please specify)	❑	❑	❑
11. other (please specify)	❑	❑	❑

5.4 Please indicate how serious you feel the problem of fatigue is for ice navigators?

not at all serious ❑ hardly at all serious ❑ moderately serious ❑ serious❑ very serious ❑

5.5 If it is *a moderately to very serious problem,* what do feel are the possible solutions? Please describe.

_____

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Questionnaire pour officiers de la navigation dans les glaces concernant les cycles de travail-repos

Ce questionnaire vise à recueillir de l'information sur la fatigue et l'état de vigilance ***chez les officiers de la navigation dans les glaces à bord de navires battant pavillon étranger et naviguant dans les eaux arctiques canadiennes***, dans le but d'améliorer la sécurité de la navigation maritime dans les eaux du Nord en isolant les causes de cette fatigue et en leur trouvant des remèdes. La présente recherche est parrainée par le Centre de développement des transports (CDT) de Transports Canada.

La recherche a été confiée à Human*systems* Incorporated, société indépendante se spécialisant dans les études portant sur les facteurs humains et l'ergonomie, qui traitera dans la plus stricte confidentialité l'information que vous lui communiquerez. Les rapports qu'elle produira ne contiendront que des données qui auront été consolidées.

Pour recueillir l'information, deux méthodes sont utilisées :

1. **Questionnaire**
   Ce questionnaire se divise en 5 parties :
   1) Conditions générales de travail
   2) Tâches et occupations de l'officier de la navigation dans les glaces
   3) Conditions de travail
   4) Organisation temporelle du travail
   5) État de fatigue

2. **Registre du cycle travail-repos**
   Il s'agit de tenir un carnet de vos activités quotidiennes et des périodes de repos au cours de vos voyages durant la présente saison de navigation.

Comment remplir ce questionnaire :

Au cours de la réunion d'aujourd'hui, nous passerons à travers ces cinq parties, l'une après l'autre.

Lorsque les explications seront terminées, veuillez répondre aux questions posées en les écrivant à même les feuilles que vous avez en main. Si vous avez besoin de plus d'espace pour écrire, écrivez au recto ou demandez-nous d'autres feuilles sur lesquelles vous aurez soin d'inscrire votre nom ou vos initiales.

Pour répondre aux questions, puisez dans vos souvenirs concernant la saison de navigation de 1996 ou, si vous êtes à la retraite, concernant la dernière saison travaillée du début à la fin.

Quand tout le monde aura fini de répondre aux questions de la première partie, nous tiendrons un débat, après quoi nous passerons à la deuxième, et ainsi de suite jusqu'à épuisement des cinq parties. N'hésitez pas à nous poser toutes les questions que vous voudrez.

Lorsque vous aurez répondu aux questions des cinq parties, nous tiendrons un débat général. Dès que vous aurez fini de répondre au questionnaire, veuillez mettre celui-ci dans l'enveloppe fournie que vous cachetterez et remettrez au consultant Human*systems*.

Si, plus tard, vous vous souvenez de détails que vous aimeriez nous faire savoir, veuillez nous les transmettre par la poste, par téléphone (appels à frais virés acceptés par Jeremy Brooks) ou par télécopieur à :

Human*systems* Inc.
111 Farquhar St.
Guelph, Ontario
N1H 3N4
Téléphone (519) 836-5911
Télécopieur (519) 836-1722

1.0. Conditions générales de travail

1.1 a) Nombre d'années où vous avez occupé le poste d'officier de la navigation dans les glaces **à bord de navires battant pavillon étranger et naviguant dans les eaux arctiques canadiennes** : _____ années sans compter l'année 1997

1.1 b) Nombre total de voyages (environ) : _____ voyages

1.1 c) Votre âge : _____ ans

1.2 Quel poste occupiez-vous avant de devenir officier de la navigation dans les glaces **à bord de navires battant pavillon étranger et naviguant dans les eaux arctiques canadiennes?**
(Exemple : 2 ans capitaine ou 7 ans capitaine en second, à bord d'un brise-glace OU en service dans l'Arctique canadien?)

Poste occupé	Années d'expérience	Type de navire	Itinéraire	Temps passé dans des eaux chargées de glaces (%)

Utilisez le tableau ci-dessous pour répondre à trois questions concernant les quatre dernières saisons durant lesquelles vous avez servi à titre d'officier de la navigation dans les glaces **à bord de navires battant pavillon étranger et naviguant dans les eaux arctiques canadiennes**

1.3 Mois du début et mois de clôture de la saison de navigation

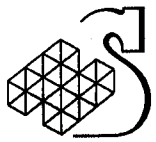
1.4 Nombre de voyages effectués durant cette saison-là

1.5 Avez-vous été affecté à des tâches s'ajoutant à celle de navigateur dans les glaces?

Oui ❑ Non ❑

Dans l'affirmative, quelles ont été ces tâches et quelle proportion de votre temps ont-elles occupé?

Année (ou les quatre dernières années d'emploi)	Durée de la saison		Nombre de voyages	Autres tâches et proportion du temps occupé par celles-ci (%)
	du mois de	au mois de		
96				
95				
94				
93				



Nous aimerions avoir un aperçu général des régions arctiques que vous avez traversées et qui peuvent avoir eu une influence sur les conditions de travail et l'état de fatigue qu'elles ont occasionné.

1.6 Utilisez les cartes fournies afin de décrire cinq parmi les voyages que vous estimez être les plus descriptifs des voyages que vous avez faits. Veuillez pour cela fournir l'information demandée en la portant sur les cartes fournies à raison d'une carte par voyage :

A. nom de votre navire et port d'armement

B. ports où le navire a fait escale avec les dates approximatives (La première date et la dernière doivent être celles de votre arrivée à bord et de votre départ, respectivement.)

C. itinéraire suivi

D. zones glacielles traversées où des conditions de travail particulières peuvent avoir eu une influence distincte sur l'état de fatigue éprouvée. Exemple :

- pack de première année dans une zone et glace dure multi-années dans une autre
- conditions météo défavorables dans une zone et favorables dans une autre
- eau profonde ou peu profonde
- avec escorte
- visibilité bonne ou mauvaise, etc.

2. Tâches et occupations de l'officier de la navigation dans les glaces

Ci-dessous, description des attributions de cet officier telle que donnée par des officiers occupant ce poste à bord du N/M *Arctic*. Prière de lire attentivement cette description et de répondre aux questions qui viennent à la suite.

À bord du N/M *Arctic*, un officier de la navigation dans les glaces doit se trouver sur la passerelle aussi longtemps que le navire se trouve dans des eaux couvertes de glaces. Le premier est le capitaine, le second, un officier compétent. Les deux se relayent l'un l'autre au bout de six heures de vigie sans interruption. L'un et l'autre peuvent s'acquitter d'autres tâches lorsqu'ils n'agissent pas à titre d'officier de la navigation dans les glaces.

L'officier de la navigation dans les glaces doit diriger la marche du navire, c'est-à-dire lui fixer une route tenant compte des conditions environnementales : glaces flottantes et submergées, état de mer, circulation maritime et conditions météo, sans dévier de la route fixée globalement par le capitaine.

Les conditions glacielles varient selon la latitude. Sous les hautes latitudes, la glace est épaisse, dure, multi-années, se dirigeant vers le sud, ou bien c'est une glace de première année, formée au cours de l'hiver précédent. Plus au sud, la banquise se fragmente en icebergs, bergy-bits et bourguignons, qui sont des glaces flottantes de dimensions décroissantes et qui s'opposent à la navigation d'une façon qui leur est particulière.

Règle générale, l'officier doit choisir une route libre de glace mais qui s'inscrit dans l'itinéraire fixé. Devant un pack, il peut décider de le contourner, de le forcer ou de l'enfoncer. Dans le cas d'un iceberg, il ne pourra que le contourner. L'officier navigateur ne doit pas seulement détecter les glaces, mais aussi en apprécier la nature et la résistance. Il peut pour cela s'aider de divers instruments, mais il doit surtout pouvoir interpréter correctement les impressions visuelles et vibratoires qu'il reçoit lorsque le navire s'approche des glaces et qu'il les heurte.

L'officier navigateur ne dirige pas le navire lui-même, mais par l'entremise du timonier à qui il donne ses instructions, mais il peut commander l'allure de marche du navire. Ainsi, lorsque plusieurs personnes se trouvent en même temps sur la passerelle pour aider l'officier navigateur dans le repérage des glaces, seul ce dernier agit à titre de navigateur, communiquant ses instructions au timonier. Au moment de la relève, la responsabilité de la navigation doit passer d'un officier à l'autre d'une façon ordonnée et manifeste.

La tâche de navigation dans les glaces exige une vigilance sans relâche. Elle consiste à apprécier continûment une situation évoluant sans cesse dans des conditions de visibilité changeantes. Pour cela, l'officier de la navigation doit adopter des attitudes perceptives et posturales propres à son rôle de vigie, mais qui finissent par fatiguer en raison du perpétuel changement dans les conditions météo et les états de mer. Inévitablement, cet état de fatigue s'accentue à mesure que le quart se prolonge, parfois pendant 24 heures consécutives, et qu'il empiète sur les périodes de repos. Or, ces dernières sont souvent gênées par diverses conditions défavorables : météo, bruit, mouvements, opération de déglaçage, etc., qui réduisent ce repos en quantité et en qualité.

2.1 La description donnée en page 5 reflète-t-elle fidèlement et complètement votre travail à bord de navires étrangers naviguant dans les eaux du Nord? Oui ❑ Non ❑

2.2 Y a-t-il une partie de cette description que vous estimez devoir être modifiée?
Oui ❑ Non ❑
Dans l'affirmative, donner les précisions voulues ci-dessous **ou** souligner la partie visée.

_____
_____
_____
_____
_____

2.3 Y a-t-il une partie de cette description qui mériterait d'être mise en évidence?
Oui ❑ Non ❑
Dans l'affirmative, donner les précisions voulues ci-dessous **ou** souligner la partie visée.

_____
_____
_____
_____
_____

2.4 Aimeriez-vous ajouter quelque chose à cette description? Oui ❑ Non ❑
Précisez.

_____
_____
_____
_____
_____

2.5 Y a-t-il une partie de cette description qui n'a rien à voir avec le travail que vous faites?
Oui ❑ Non ❑
Précisez.

_____
_____
_____
_____
_____

3. Conditions de travail

Cette section se divise en deux parties : conditions de travail et conditions de vie à bord.

3.1 À bord des navires étrangers, quelle était la proportion de ces navires se trouvant dans l'une des catégories décrites ci-dessous :

Conditions générales de travail				
Navires battant pavillon étranger	médiocre	satisfaisant	bon	Total
État général de propreté de la passerelle				100 %
Aménagement général de la passerelle				100 %
Présence d'instruments, d'un équipement appropriés				100 %
État général de ces instruments, de cet équipement				100 %
Visibilité à travers les fenêtres de la passerelles : obstacles intérieurs à la vision, accumulation de glace, etc.				100 %
Climatisation de la passerelle (chauffage, ventilation, etc.)				100 %
Communication avec le capitaine et les autres occupants de la passerelle				100 %
Expérience du capitaine en navigation dans les eaux arctiques canadiennes				100 %
Autres (prière de préciser)				100 %
Autres (prière de préciser)				100 %
Autres (prière de préciser)				100 %

3.2 Si vous avez décrit une condition comme médiocre, veuillez préciser la ou les raisons exactes qui vous la font décrire ainsi.

_____

_____

_____

_____

3.3 Estimez-vous que cette condition était médiocre au point de compromettre gravement votre travail? Oui ☐ Non ☐ De quelle manière?

_____

_____

_____

_____

_____

3.4 Quelle était la proportion des navires battant pavillon étranger qui se trouvaient dans l'une des catégories décrites ci-dessous :

Conditions générales de vie à bord				
Navires battant pavillon étranger	médiocre	satisfaisant	bon	Total
Nourriture				100 %
Communication avec les membres de l'équipage				100 %
Installations de couchage				100 %
Climatisation (chauffage, ventilation, etc.)				
Autres (prière de préciser)				100 %
Autres (prière de préciser)				100 %
Autres (prière de préciser)				100 %

3.5 Si vous avez décrit une condition comme médiocre, veuillez préciser la ou les raisons exactes qui vous la font décrire ainsi.

_____

_____

_____

_____

_____

_____

3.6 Estimez-vous que cette condition était médiocre au point de compromettre gravement votre travail? Oui ☐ Non ☐ De quelle manière?

_____

_____

_____

_____

_____

_____

4. Organisation temporelle du travail

Cette section se divise en deux parties : organisation théorique et organisation pratique.

4.1 Dans votre travail, suiviez-vous un calendrier de base théorique? Oui ❑ Non ❑
Dans l'affirmative, veuillez répondre aux deux questions suivantes :

4.1 a) Comment le travail était-il organisé? (4 heures travail et 8 heures repos, 6 heures et 6 heures, ou autre?)

_____
_____
_____
_____

4.1 b) Ce calendrier, le respectiez-vous? (cocher une case)
Pas du tout ❑ Rarement ❑ Une fois sur deux ❑ D'assez près ❑ De très près ❑

Pour les questions 4.2 à 4.6, Tâche ICE NAV + AUTRE tâche + SOMMEIL + autres activités = 24 heures

4.2 Dans la pratique, combien d'heures en moyenne par jour faisiez-vous de la navigation dans les glaces?_____ heures

4.3 Combien d'heures en moyenne par jour consacriez-vous aux autres tâches, si vous en faisiez?
_____ heures

4.4 Sur le nombre d'heures hors service, combien consacriez-vous en moyenne au sommeil par jour?_____ heures

4.5 Estimez-vous qu'en moyenne vous disposiez d'une quantité suffisante d'heures de sommeil?
Oui ❑ Non ❑

4.6 Estimez-vous que la qualité de votre sommeil était adéquate? Oui ❑ Non ❑
Dans la négative, dire pourquoi.

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

5. État de fatigue

5.1 Trouvez-vous que l'état de grande fatigue où vous vous trouviez parfois pouvait compromettre gravement votre travail? Oui ❑ Non ❑

Dans l'affirmative, cela arrivait :

presque jamais ❑ rarement ❑ une fois sur deux ❑ souvent ❑ très souvent ❑

5.2 De toutes les raisons ayant trait au *cycle travail-repos* et susceptibles de causer un état de fatigue, lesquelles mettriez-vous en évidence parmi celles évoquées ci-dessous?

Cycle travail-repos	
1. Cycle de travail trop long	❑
2. Cycle de travail trop variable	❑
3. Cycle de repos trop court avant la reprise du travail	❑
4. Heures de repos insuffisantes au bout de plusieurs jours	❑
5. Cycle de travail commençant trop tôt le matin	❑
6. Cycle de travail commençant en soirée	❑
7. Heures de service se faisant de nuit	❑
8. Trop peu d'occasions propices à une pause	❑
9. Trop peu d'occasions propices à un sommeil de courte durée	❑
10. Heures de sommeil insuffisantes	❑
11. Sommeil interrompu ou de piètre qualité	
12. Autres raisons (préciser lesquelles)	❑

5.3 De toutes les raisons ayant trait à la *charge de travail* et susceptibles de causer un état de fatigue, lesquelles mettriez-vous en évidence parmi celles évoquées ci-dessous?

Charge de travail	
12. Trop lourde à cause des conditions glacielles	❑
13. Trop lourde à cause de la mauvaise visibilité	❑
14. Trop lourde à cause des conditions de travail sur la passerelle	❑
15. Trop lourde à cause des difficultés éprouvées avec le capitaine ou les autres membres d'équipage	❑
16. Trop lourde à cause de la nécessité de demeurer en position debout pendant longtemps	❑
17. Trop lourde pour d'autres raisons...	❑
18. Autres raisons (préciser lesquelles)	❑
19. Autres raisons (préciser lesquelles)	❑

5.4 Avez-vous éprouvé l'un des symptômes de fatigue suivants pendant un cycle de travail?

Symptômes	**Fréquence**		
	jamais	parfois	souvent
1. Perte de mémoire	❑	❑	❑
2. Facilité à être distrait	❑	❑	❑
3. Difficulté à se concentrer	❑	❑	❑
4. Manque de motivation	❑	❑	❑
5. Intervenir au mauvais moment	❑	❑	❑
6. Désir de s'asseoir ou de se coucher	❑	❑	❑
7. Fatigue musculaire	❑	❑	❑
8. Difficulté à garder les yeux ouverts	❑	❑	❑
9. Maladresse	❑	❑	❑
10. Autres (prière de préciser)	❑	❑	❑
11. Autres (prière de préciser)	❑	❑	❑

5.5 À votre avis, le problème de la fatigue chez les officiers de la navigation dans les glaces :
est sans gravité ❑ pas très grave ❑ assez grave ❑ grave ❑ très grave ❑

5.6 Si vous l'estimez *assez grave, grave ou très grave*, quelles seraient d'après vous les solutions qui s'imposent? Développez vos idées là-dessus.

Annex B

Duty/rest log

The content of the duty/rest log is shown in this Annex. Note the original booklet measured 16 x 11 cm.

Canadian ice navigators On Board Foreign Registered Vessels in Canadian Arctic Waters

Human*systems* Incorporated
111 Farquhar Street
Guelph, Ontario
Canada
N1 h 3N4

Tel: (519) 836-5911
Fax: (519) 836-1722

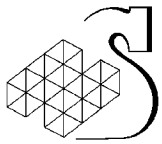
All information provided will be kept in confidence.

(outside cover page)

NAME:

VOYAGE DESCRIPTION: **(eg. Ports of call; dates entering and leaving ports)**

(inside cover page)



INSTRUCTIONS

Please keep a record of all your activities during your voyage using the duty/rest log provided (instruction follow on the next page).

Fill out the log at the **end** of each activity or soon after a set of activities. If you forget to fill out the log, please say so indicating the missing time period(s) and reason(s).

Please use the Comment section at the end of this booklet to report any difficulty you encountered during your voyage that compromised how well you were able to do your work. In particular, did you experience any difficulty associated with your work schedules and hours of rest?

(first page)

The log includes 3 sections: activity, time and your assessment of how *tired* or *wakeful* you feel.

1. The ACTIVITY section indicates *what* you were doing. The five activities are described below. At the **end** of the activity, use the short form (bold letters) to mark the activity on the log (see example opposite).

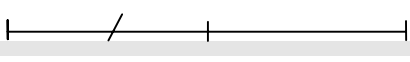
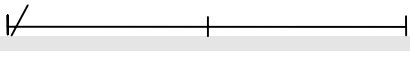
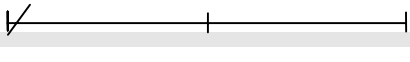
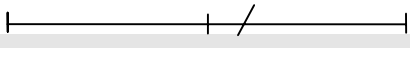
dp duty period - time on duty spent working
slp sleep - time spent in a bunk with the intention of falling asleep
rec recreation - all other rest time
ps pause - brief rests taken during duty for eating drinking or personal needs (bridge command is handed to another person)
np nap - includes naps taken during duty or rest i.e.,
During **duty** a nap is a brief period of sleep taken in a chair or similar situation.
During **rest** a nap is taken in a chair or briefly lying on a bunk without changing clothes.

2. The TIME section includes the date, start and end time of each activity. After marking the activity, fill out the date, start and end time of the activity. (see example opposite).

3. The TIRED/WAKEFUL rating indicates how tired or wakeful you are at the **end** of the activity. After marking the activity and time, place a mark **anywhere** on the line which corresponds to how tired or wakeful you feel at that moment. A mark at the far left end means you are ***struggling to remain awake***. A mark at the far right end means you are ***active, vital, wide awake***. (see example opposite).

(second page)

EXAMPLE….

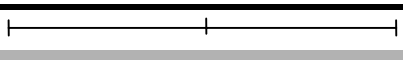
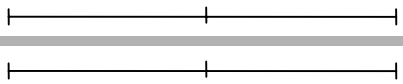
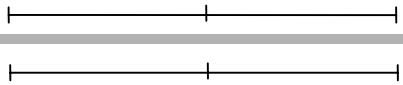
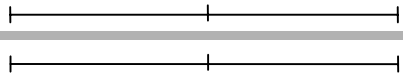
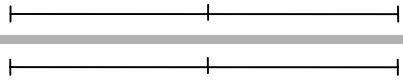
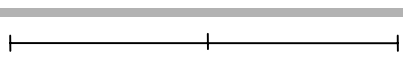
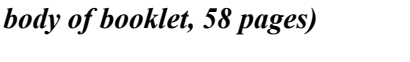
Activity	TIME			TIRED/WAKEFUL RATING (after activity)
	date (mth:day)	start (hr:min)	end (hr:min)	very tired / tired / borderline / wakeful / very wakeful
dp	june 25	0100	0300	
ps		0300	0310	
dp		0310	0400	
rec		0400	0430	
slp		0430	0730	

MEANING…. 0300 felt somewhat tired, been on duty since 0100. Took ten-minute pause from duty (perhaps washroom) and felt a little bit tired. After another 50 minutes on duty, ended at 0400, felt more tired. Began recreation at 0400 ending at 0430 feeling tired. Slept and woke up at 0730 feeling quite wakeful but not in top form.

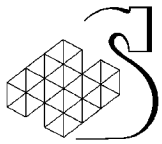
(third page)

ACTIVITY KEY

dp duty period **slp** sleep **rec** recreation
ps pause **np** nap

Activity	Time			Tired/Wakeful
	date (mth:day)	start (hr:min)	end (hr:min)	very tired / tired / borderline / wakeful / very wakeful
				
				
				
				
				
				
				
				
				

(main body of booklet, 58 pages)



COMMENTS

Date	Time	Comment

(last 3 pages and inside cover at the back of booklet)