TP 12974E

Study of One-person Train Operations

Prepared for
Transportation Development Centre
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Transport Canada

Beauchemin – Beaton – Lapointe Inc.
CONSULTING ENGINEERS

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16. Abstract

This report presents the findings of a review of one-person train operations. One-person train operation has not gained large-scale application in North America. All other railways contacted operate one-person trains and none of them operate driverless trains over the road.

Some railways use sophisticated technologies to enforce signal and speed regulations while others use advance warning systems which warn the driver and enforce signals. Most railways provide means (radio or telephone) of continuous and direct speech communication between the driver and the controller.

The driver has the primary responsibility for safe operation of the train and is required to attend to problems arising with the train en route.

The drivers work in shifts from 7 to 14 hours, for a total of 35 to 50 hours per week. A minimum of a 10- to 12-hour break is allowed between shifhts. Generally, a minimum of a 30-minute break is allowed after a 5-hour run. Most railways are concerned about driver fatigue and relieve drivers when they are tired or sick.

All new drivers are given initial training followed by periodic competence assessment. Deficiencies are rectified.

The railways find the one-person safety record to be excellent and do not believe that two persons in the cab improves safety.

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16. Résumé

Ce rapport présente les résultats d'une étude sur les sociétés ferroviaires utilisant une seule personne pour la conduite des trains. La monoconduite des trains n'est pas répandue en Amérique du Nord. Ailleurs, les sociétés ferroviaires visées par l'étude font conduite leurs trains par un seul agent et aucune n'utilise la conduite entièrement automatisée, sans conducteur.

Certaines sociétés ont des moyens technologiques perfectionnés pour faire observer la signalisation et les limites de vitesse alors que d'autres utilisent des systèmes de répétition pour avertir le conducteur et assurer le respect de la signalisation. La plupart des sociétés ferroviaires possèdent des moyens de communication vocale directe et continue (par radio ou téléphone) avec le conducteur de la locomotive.

Le conducteur est le premier responsable de la sécurité du train; c'est également lui qui doit intervenir si des problèmes se produisent en cours de route.

Les conducteurs travaillent par postes de 7 à 14 heures, jusqu'à concurrence de 35 à 50 heures par semaine. Un repos d'au moins 10 à 12 heures est prévu entre chaque poste de travail. Habituellement, une pause de 30 minutes, au moins, est permise après un parcours de 5 heures. La plupart des sociétés ferroviaires se préoccupent de la fatigue de leurs conducteurs, qu'ils remplacent lorsqu'ils sont fatigués ou malades.

Tous les nouveaux conducteurs reçoivent une formation initiale suivie d'une évaluation périodique de leur compétence, avec correction des lacunes.

Les sociétés ferroviaires utilisant un seul agent de conduite considèrent comme excellent leur dossier de sécurité et elles n'estiment pas que l'utilisation de deux personnes améliore la sécurité.

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EXECUTIVE SUMMARY

INTRODUCTION

This report presents the findings of a review of one-person and driverless train operations. The objective of the project was to identify and characterize one-person and driverless train operations.

For the purposes of this study, a one-person train operation is defined as a train operated by one driver only and, when there is other crew on board the train, that crew has no normal role in running of the train.

One-person train operations have not gained large-scale acceptance by North American railways. The greater part of this study therefore relates to railways outside of Canada. Railway officials around the world were approached by telephone in order to gather information on their operations.

OPERATIONS IDENTIFIED

While all the railways contacted operate one-person trains (i.e., with only one driver in the locomotive), none of them operate driverless trains over the road.

Most railways do not impose any restriction on the use of one-person operations. British railways do not permit one-person operations for transport of toxic and flammable substances, for particular types of freight equipment, and where certain track and communication requirements are not met. Tranzrail of New Zealand does not permit one-person operations in areas where full and continuous radio communication is not available.

CLASS AND TYPE OF OPERATIONS

Both passenger and freight trains are operated with only one person in the locomotive. Freight trains have no other crew on board. Most passenger trains, however, have other crew on board for passenger service and security with the exception of suburban, local, and regional trains, where suitable equipment can be deployed to permit the driver to operate and supervise the doors.

All types of freight trains are run as one-person operations. These trains include mixed freight, industrial freight, intermodal freight, block trains, and heavy haul trains. Passenger one-person trains include suburban trains, local trains, regional trains, intercity trains, and long-distance trains.

TECHNOLOGY

Cab Technology

Some railways such as the Danish and Swedish railways use sophisticated ATC technologies to enforce signal and speed regulations.

British railways use an audio-visual driver safety device called an AWS (Advance Warning System) which warns the driver of signal aspects. A driver's failure to acknowledge the restrictive signal warnings results in automatic braking of the train. Tranzrail uses only a vigilance device which sounds an alarm and stops the train if the driver fails to respond to its demands.

Communication System

Most railways provide a radio communication system to permit continuous and direct speech communication between the driver and the controller. British railways permit use of a telephone connecting with the controlling signal box every 3.2 kilometres along the line in lieu of radio communication.

DRIVER'S TASKS

The driver has the primary responsibility for safe operation of the train. He is required to attend to problems arising with the trains en route, deal with emergencies, and call for assistance where necessary. Generally, the drivers follow specified rules when leaving the cab and while outside.

DRIVER'S SCHEDULE

The drivers work in shifts ranging from 7 to 10 hours, for a total of 35 to 50 hours per week. Some railways allow longer shifts. The drivers are allowed a minimum of 10- to 12-hour breaks between shifts. The German Railway requires a break of at least 5 hours between shifts at an out-of-tour location. Most railways allow a minimum of a 30-minute break after a maximum of a 5-hour run. The break is taken at the driver's discretion.

Most railways are concerned about the driver fatigue problem and relieve drivers when they are tired or sick. Tranzrail is presently developing a crew alertness education program which will educate drivers on how the body functions and on how to organize work, sleep, etc.

DRIVER TRAINING

All new drivers undergo a year to eighteen-month training period. Following the initial training and certification, driver competence is assessed periodically and action is taken to correct any deficiencies.

Tranzrail ran special two-day training courses on new operating rules and a radio communication system when one-person operation was introduced.

EMERGENCY PROCEDURES

The drivers are trained in procedures to protect the train and can request emergency assistance when necessary. On the other hand, if the train is delayed or stopped en route without apparent reason, and the driver cannot be contacted within a given time, an emergency is assumed by the controller and appropriate procedures are initiated.

GENERAL EXPERIENCE WITH ONE-PERSON OPERATIONS

All the railways found the one-person safety record to be excellent and do not believe that two persons in the cab improves safety. The drivers were initially opposed to the concept but the system now has gained wide acceptance.

SOMMAIRE

INTRODUCTION

Le présent rapport fait état des résultats d'une étude portant sur la conduite des trains par une seule personne et sur la conduite automatique sans agent de conduite à bord. Le projet avait pour but de constituer une base d'informations sur les sociétés ferroviaires qui confient la conduite de leurs trains à une seule personne, ou dont la marche des trains est entièrement automatisée, sans présence d'agent de conduite à bord.

Aux fins de la présente étude, la marche des trains faisant appel à un seul agent de conduite désigne la conduite des trains par une seule personne; même si un autre employé peut se trouver dans la cabine de conduite, cette autre personne ne joue aucun rôle dans la conduite proprement dite du train.

La monoconduite n'a pas trouvé une grande acceptation chez les sociétés ferroviaires nord-américaines. Par conséquent, la majeure partie de ce rapport concerne des sociétés ferroviaires étrangères; on a communiqué par téléphone avec les représentants de sociétés ferroviaires partout dans le monde afin de cueillir des informations sur leurs opérations.

SOCIÉTÉS FERROVIAIRES ÉTUDIÉES

Bien que la totalité des sociétés de chemin de fer sondées exploitent leurs trains à l'aide d'une seule personne (c'est-à-dire qu'il y a seulement un agent de conduite dans la locomotive), aucune n'exploite des trains sans conducteur ni mécanicien.

La plupart des sociétés ferroviaires n'imposent aucune restriction quant à la conduite par un seul conducteur. Les chemins de fer britanniques n'autorisent cependant pas la monoconduite pour le transport de substances toxiques et inflammables, pour des types particuliers de matériel de transport de marchandises, et en l'absence de certaines conditions ayant trait à la voie et aux communications. En Nouvelle-Zélande, la société Tranzrail ne permet pas la monoconduite de ses trains dans les régions où il n'existe pas de communications complètes et continues par radio.

CLASSES ET TYPES D'OPÉRATIONS

Chez les sociétés qui ont été inclues dans l'étude, ce sont les trains de voyageurs et les trains de marchandises qui roulent avec un seul agent de conduite. Dans le cas des convois de marchandises, le conducteur est seul à bord du train, aucun autre membre d'équipage ne s'y trouvant. Or, pour la plupart des trains de voyageurs, d'autres membres d'équipage sont à bord pour assurer le service aux voyageurs et pour veiller sur leur sécurité, à l'exception des trains de banlieue, des trains locaux et des trains régionaux, qui sont munis d'un équipement approprié pour que le conducteur puisse commander et surveiller lui-même les portes.

Tous les types de trains de marchandises sont exploités en monoconducteur, entre autres les trains mixtes, les trains industriels, les trains-blocs, les trains à fort tonnage et les trains affectés au transport intermodal. Les trains de voyageurs confiés à un seul agent de conduite comprennent les trains de banlieue, les trains locaux, les trains régionaux, les trains intercité et les trains effectuant de longs parcours.

TECHNOLOGIE

Technologie utilisée en cabine

Certains chemins de fer, par exemple ceux du Danemark et de la Suède, recourent à une technologie de pointe pour le contrôle automatique de la marche des trains dans le but de faire respecter la signalisation et les limites de vitesse.

Les sociétés ferroviaires britanniques utilisent un dispositif de sécurité audiovisuel AWS (Advance Warning System), qui informe le conducteur de l'aspect du signal. Si le conducteur ne confirme pas l'avertissement communiqué par un signal restrictif, il se produit une application automatique des freins. La société Tranzrail, quant à elle, utilise seulement un dispositif de vigilance qui provoque le déclenchement d'une alarme sonore et l'arrêt du train lorsque le conducteur ne fait pas les actions requises.

Système de communication

La plupart des sociétés ferroviaires ont des systèmes de communication radio qui permettent une communication vocale directe et continue entre le conducteur et le contrôleur. Chez les sociétés britanniques, on utilise plutôt un téléphone pouvant être raccordé à une boîte de contrôle de signalisation, tous les 3,2 kilomètres le long de la voie.

TÂCHES DU CONDUCTEUR

La première responsabilité du conducteur est d'assurer la marche du train en toute sécurité; il doit également s'occuper de toute anomalie pouvant survenir en cours de route, régler les situations d'urgence et demander de l'aide au besoin. En général, les conducteurs sont tenus d'observer des règles spécifiques lorsqu'ils quittent la cabine et lorsqu'ils ne sont pas à bord du train.

HORAIRE DE TRAVAIL

Les postes de travail des agents de conduite sont d'une durée de 7 à 10 heures, ce qui représente un total de 35 à 50 heures de travail par semaine. Certaines sociétés ont des postes de travail plus longs. Les agents de conduite bénéficient d'une période de repos de 10 à 12 heures entre chaque poste de travail. Les chemins de fer allemands exigent entre les postes de travail un repos d'au moins 5 heures pris en dehors du lieu de travail. Enfin, la plupart des sociétés ferroviaires autorisent une pause de 30 minutes après un parcours de 5 heures; cette pause est laissée à la discrétion du conducteur.

La majorité des sociétés ferroviaires s'intéressent au problème de la fatigue des conducteurs et assurent leur remplacement en cas de fatigue ou de maladie. Le transporteur Tranzrail est actuellement à mettre au point un programme d'éducation sur la vigilance des équipages, qui a pour but d'enseigner aux conducteurs le fonctionnement du corps humain et de leur montrer comment gérer leur temps de travail, leur temps de sommeil, etc.

FORMATION DES CONDUCTEURS

Tous les nouveaux conducteurs doivent passer par une formation d'une durée de douze à dix-huit mois. Après cette première formation, accompagnée d'une certification, on évalue à intervalles réguliers la compétence du conducteur et les faiblesses relevées sont corrigées.

Lors du passage à la monoconduite des trains, Tranzrail a organisé des cours spéciaux d'une durée de deux jours sur les nouvelles règles d'exploitation ainsi qu'un cours sur les systèmes de radiocommunications.

PROCÉDURES D'URGENCE

Les conducteurs reçoivent une formation sur les procédures de protection des trains; ils peuvent néanmoins demander des secours si la situation l'exige. Par contre, si le train est en retard ou s'il s'arrête en route sans aucune raison apparente et que le conducteur ne peut être rejoint dans un délai déterminé à l'avance, le contrôleur présume qu'il existe une situation urgente et il déclenche alors les mesures appropriées.

EXPÉRIENCE GÉNÉRALE DE LA MONOCONDUITE DES TRAINS

Toutes les sociétés ferroviaires ont trouvé excellent leur dossier de sécurité en monoconduite; de plus, toutes estiment que la présence de deux membres d'équipage dans la cabine de conduite n'améliore pas la sécurité. Au début, les conducteurs se sont opposés au concept de conduite par un seul agent, mais cette pratique est maintenant généralement acceptée.

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1 INTRODUCTION

The Transportation Development Centre mandated Beauchemin-Beaton-Lapointe Inc. to collect information on one-person and driverless train operations for evaluation against train operations in Canada. The objective of the project is to identify and characterize one-person and driverless train operations outside of Canada.

This report presents the methodology used for information gathering, a summary of the information obtained on one-person operations, and a list of contacts for further information and discussions.

For the purpose of this study, one-person train operation is defined as a train operated by one driver only, and when there is other crew on board the train, that crew has no normal role in running the train.

2 METHODOLOGY

The main activity consisted of gathering information on one-person operations from the railways around the world. The information gathering was by telephone interviews with railway officials.

For the purpose of this study the railways were divided into two groups: North American railways, and world railways.

North American Railways

One-person train operations have not gained wide-scale acceptance on North American railways. Amtrak operates passenger trains with only one driver in the locomotive (there are other crews in the cabins for passenger service and safety) on a limited scale. Such operations are confined to Washington-New York-New Haven section of the Northeast Corridor. In addition, Wisconsin Central operates one-person freight trains on a few short routes.

Transport Canada officials were familiar with the Wisconsin Central operations. Contact with the North American railways was therefore limited to Amtrak.

World Railways

A large part of this study relates to world railways. Initially, a list of ten railways, considered to have a high probability of one-person operations, was developed from the Railway Directory. These railways are:

- Belgium National Railway;
- Berne-Loetschberg-Simplon (Swiss) Railway;
- British Railway Board;
- Danish State Railway;
- Deutsche Bahn A.G. (German Railway);
- Netherlands Railways;
- New Zealand Rail Ltd;
- Swedish National Railway;
- Swedish State Railway;
- VR Group Ltd. (Norway).

Australian railways were excluded because their operating characteristics are known to Transport Canada.

As the study progressed the list was refined and other railways were identified. Those railways where suitable contacts could not be developed were dropped from the list.

3 OPERATIONS IDENTIFIED

Meaningful information on one-person operations was available from the following railways:

- Danish State Railway;
- Deutsche Bahn AG (DB AG-German Railway);
- English, Welsh and Scottish Railway (U.K.);
- Freight Liner (U.K.)
- Great North Eastern Railway (U.K.);
- Ore Line (Sweden);
- Swedish State Railway (Sweden);
- Tranzrail (New Zealand).

None of these railways operates driverless trains over the road. On the other hand, all the railways operate one-person trains (i.e., with only one driver in the locomotive) and, on several railways, one-driver operations are the only mode of operation. On these railways,

- freight trains are mostly one-person operations;

- passenger trains use only one driver in the locomotive, however there is other crew in passenger cabins on board most trains for passenger service and safety. These crews usually have no role in operating the train;

- over the road one-person operation of passenger trains, with no other crew on board, is limited to suburban and local trains provided suitable equipment can be deployed which permits the driver to operate and supervise doors.

None of these railways, with the exception of British railways and Tranzrail, impose any restriction on use of one-person operations. British railways do not permit one-person operations:

- for transport of toxic gases, radioactive substances, hydrocyanic acid and trains carrying more than one wagon or container of flammable gases;

- for use of such vehicle types as 2- or 3-axle service vehicle without appropriate brakes, and hopper wagons 24/75t, etc;

- over lines adjacent to non-circuited passenger tracks unless the communication system permits either direct speech radio communication between the driver and the controller of the controlling signal box.

Tranzrail does not permit one-person operations in areas where full and continuous radio communication is not available. German Railway requires that a second crew member – driver's assistant – be placed in the control unit if certain technical safety systems, for example "deadman", malfunction.

Operating characteristics of these railways are summarized in the following sections. Detailed information on each railway is provided in Section 5.

4 OPERATING CHARACTERISTICS

CLASS OF OPERATIONS

Both passenger and freight trains are operated with only one person in the locomotive. Freight trains have no other crew on board. Most passenger trains, however, have other crew on board for passenger service and safety.

TYPES OF OPERATIONS

Freight trains

All types of freight trains are run as one-person operations. These trains include mixed freight, industrial freight, intermodal freight, block trains, and heavy haul trains, etc.

Passenger trains

Suburban, local, and regional passenger trains, where suitable equipment can be deployed, are operated with a single person in the locomotive and no other crew on board. The passenger equipment in this case must enable the driver to close, lock, and supervise the passenger doors.

All other passenger trains, especially intercity and long distance trains, have other crew on board.

TECHNOLOGY

Cab Technology

Some railways such as the Danish and Swedish railways use sophisticated Advanced Train Control (ATC) technologies to provide advance warning to the driver. Should the driver fail to respond to the signal and speed warnings, the ATC intervenes and enforces the regulations.

British railways use an audio-visual driver safety device called an AWS (Automatic Warning System). The AWS comprises a “sunflower”, a bell, and a horn. The bell rings as the locomotive passes a green signal. At restrictive or caution signals, the horn sounds instead of the bell, and the “sunflower” turns yellow. The driver must acknowledge the restriction by pressing a button. Failure of the driver to do so results in automatic braking of the train. Brake application cuts off traction.

Tranzrail uses perhaps the simplest technology. Tranzrail engines are equipped with a vigilance device which requires the driver to touch a certain sequence of objects once every 50 to 60 seconds. A light comes on if the driver fails to do so. The driver must cancel the light within 5 to 10 seconds. Failure to cancel the light sounds an alarm, and brakes are applied if the driver fails to respond to the alarm.

Brake System

All the railways use air brakes. British railways require that an automatic air or vacuum brake system must be operative throughout the train for one-person operations.

Communication System

Most railways provide radio communication systems to permit continuous and direct speech communication between the driver and the controller. Tranzrail does not permit one-person operations in areas where such a system is not available.

On British railways, when operating one-person trains over passenger lines, the driver must be provided either with a radio communication system as described above, or a telephone connecting with the controlling signal box every two miles along the line.

Swedish railways equip their locomotives with several telephone systems: A 450 MHz, NMT public mobile telephone (cellular system); a special train order radio system for communication with CTC; and mobile telephones which can be connected to any telephone post along the track.

DRIVER'S TASKS

The driver's tasks are very similar on all the railways contacted. The driver:

- has the primary responsibility for safe operation of the train;
- is required to deal with emergencies en route which might safe operation of the train;
- may have to leave the cab if a problem arises with the train en route, inspect and rectify the problem where possible, and call for assistance where necessary;
- must follow specified rules when leaving the cab and while outside.

(Ore Line indicated that the driver has the right to decline to perform the tasks outside the cab if he perceives the risk in leaving the cab to be too high because of inclement weather or any other reason).

DRIVER'S SCHEDULE

On most railways the drivers work in shifts ranging from 7 to 10 hours. Tranzrail allows a maximum shift length of 11.5 hours and Ore Line allows a maximum shift length of 14 hours. Total number of hours worked per week range from 35 to as many as 50. The drivers are generally allowed a minimum of 10- to 12-hour breaks between shifts.

Most railways allow a 30-minute break after a 3.5- to 5-hour run. The break is taken at the driver's discretion and the railways generally do not object if the break is not taken.

Most drivers are aware of their work schedules considerably in advance. For example, on Tranzrail, the driver schedule is known a minimum of 8 weeks in advance. On Ore Line, the driver schedule may be known as much as six months in advance. There is no schedule for reserve drivers and it is therefore not known in advance.

Most railways are sensitive to the problem of driver fatigue and relieve drivers when they report in tired or sick.

Tranzrail is presently developing a crew alertness education program which will educate drivers on the functioning of the human body and on how to organize work and sleep, etc. The alertness education program is being developed by Professor Philippa Gander of the U.S. who has already developed similar programs for American airline crews.

DRIVER TRAINING

Driver training programs vary. In general, all drivers are given initial training of one year to eighteen months. Following the initial training and certification, the driver competence, and compliance with the rules, are assessed periodically. Action is taken to correct deficiencies where necessary. Ore Line also provides 1 to 2 days refresher training each year after the initial training and certification.

Tranzrail ran special two-day training courses on new operating rules and radio communication system when one-person operation was first introduced.

EMERGENCY PROCEDURES

Emergency procedures vary between the railways. In general, the drivers are trained in procedures to protect the train and can request emergency assistance when necessary. On the other hand, if the train is delayed or stopped en route without apparent reason and the driver cannot be contacted within a given time, an emergency is assumed by the controller and appropriate procedures are initiated.

Tranzrail equips its locomotives with an emergency alert button which sends a priority signal to the dispatcher. The driver can invoke emergency by pushing the button. Alternatively, if the alerter in the locomotive goes full cycle and applies the brakes, the dispatcher is alerted and emergency procedures are initiated.

Choice of the means of emergency assistance depends upon each railway’s particular circumstances and varies from assistance provided by meeting or passing train to dispatching of inspection vehicle, another engine, ambulance, fire vehicles, or relief vehicles.

Intervention to support the driver en route is required only occasionally, generally for switching disabled and damaged cars. However, such instances are infrequent. Ore Line experiences about 15 to 20 such occurrences per year and provides assistance by a meeting train.

It is rare that a driver needs relief or assistance en route due to sickness or injury.

GENERAL EXPERIENCE WITH ONE-PERSON OPERATION

All the railways find the one-person safety record to be excellent and do not believe that two persons in the cab improves safety. The drivers were initially opposed to the concept but the system now has gained wide acceptance.

5 SURVEY OF ONE-PERSON TRAIN OPERATIONS

The railways contacted can be divided into three categories:

- Freight Only Railways: This group includes Ore Line (Sweden), and (Freight Liner), U.K.;
- Freight and Passenger Railways: These railways include Danish State Railway (Denmark), Tranzrail (New Zealand), Swedish State Railway (Sweden), and English Welsh and Scottish Railway (U.K.);
- Passenger Only Railways: These railways include Amtrak (U.S.), and Great North Eastern Railway (U.K.).

Operations of these railways are described in the following sections.

5.1 Freight Only Railways

5.1.1 *One Line (Sweden)*

The Ore Line operates one-person trains only and runs on electric traction. The trains are 5 200 tonnes and comprise 52 cars and 1 locomotive. The system transports 25 million annually and operates 22 trains per day: 12 trains from Kiruna to Narvik on the Atlantic Coast, a distance of 175 km, 5 trains from Kiruna to Lulea, a distance of 210 km, and 5 trains from Kiruna to Svappavaara, a distance of 48 km. The train speed is 50 km/h loaded and 60 km/h empty.

The Ore Line (called MTAB) is a private rail company owned by the iron ore company. Its administration is independent, although, for the time being, it still uses the Swedish State Railway crew.

Most of the railway is located north of the Arctic Circle. A location plan is shown in Figure 1.

The railway is located in an extreme climate region where the temperature drops below -15°C in December, January and February and seldom rises above 10°C in summer months from May to September. The duration of snow cover in the region is 160 to 240 days and the depth of snow cover varies from 1 000 mm to 1 600 mm. Figures 2 to 4 show the climatic data for the railway.

The railway passes through a mountainous region and most of the alignment is on curves of varying degrees. On the Kiruna-Narvik line, the track reaches an altitude of 600 m near the Norwegian border and descends towards the sea. The average grade on this section is in the order of 1.5 percent for a length of about 40 km. Figures 5 to 9 show the track alignment data.

CLASS OF OPERATIONS

Freight.

TYPES OF OPERATIONS

Heavy haul, iron ore and iron ingots.

TECHNOLOGY

Cab Technology

The locomotives are equipped with an ATC system. The ATC provides advance information and prompts the driver to take action with respect to signals and speeds. If the driver fails to take action, the ATC takes over control of the train and initiates necessary actions. Functioning ATC is mandatory on all locomotives. When ATC malfunctions, the driver must proceed with caution and at slow speed to the next station where ATC can be restored or the locomotive replaced. The ATC system on Swedish railways is 10 to 15 years old and has recently been upgraded. The system supplier is Asea Brown Boveri (ABB).

The ATC was apparently installed following an incident attributed to “micro napping.”

Communication System

The locomotives are equipped with several telephone systems:

- 450 MHZ, NMT public mobile telephone (cellular system);
- Special train order radio system for communication with the controller (only);
- Stationary telephones at signal posts at about 9-km intervals;
- Mobile telephone which can be connected to any telephone post along the track. These posts are at about 1.5-km intervals.

Use of stationary and mobile telephones is becoming infrequent and may eventually be phased out.

Most information to the drivers is given through the signals. The driver does not listen to the communication between the dispatcher and other trains and therefore is not aware of locations of other trains in the vicinity as a matter of routine. However, information on preceding or succeeding trains can be made available by radio telephone communication between the driver and the dispatcher.

Brake System

The Ore-line trains are equipped with air brakes.

DRIVER’S TASKS

The drivers have the responsibility to test the engine and train equipment and to operate and protect the train. The drivers are trained for and expected to examine/attend to problems arising with the train equipment (brakes, hot axles, etc.) en route. However, the driver can decline to perform the tasks outside the cab if he perceives the risk in leaving the cab to be too high due to inclement weather or any other reason.

Whenever the driver leaves the cab, he advises the controller that he is leaving the cab and will return after X minutes. If he must stay outside the cab longer, he must so advise the controller and specify a new duration. If contact is lost with the driver, the controller assumes an emergency has arisen and initiates emergency procedures.

The trains carry on board track circuit clips. The drivers are provided with special clothing (warm overalls) for use in emergencies such as power failure, extended exposure outside the cab, etc.

There is no staff at the wayside stations.

DRIVER'S SCHEDULE

The normal working day is 8 to 10 hours with a maximum of 14 hours. The drivers are entitled to a minimum of 30 minutes break after 5-hour runs under the present agreement between the railway and the drivers' union (the Kiruna-Narvik run is 4 hours; drivers usually get a 1½ hour break before starting the return journey).

In cases of delays en route, when normal workday hours are exceeded, the driver is called upon to make a judgment if he can bring the train safely to the destination. He can ask for relief if he so chooses.

The drivers work on a 4-week schedule cycle. During each 4-week cycle they may not be asked to work on more than two Sundays.

Drivers' schedules are prepared at the time of train scheduling and may be known as much as six months in advance.

There is no schedule for reserve drivers (relief in case of emergencies).

DRIVER TRAINING

- All drivers are trained for one-driver operation. Identical training is given to all drivers whether they are recruited from within the railway or from the outside.
- A one-year initial training certifies a driver for operation of all trains. Operation of Ore trains requires only an 8-month initial training.
- The training sequence is as follows:
  - 3 days introduction;
  - 27 days of safety rule training in training school;
  - 30 days on the road with an instructor (older, experienced driver);
  - back to school for 30 days of more safety rules and engine systems training;
  - 44 days on the road with an instructor;
  - back to school for 30 days additional training;
  - 20 days on the road with an instructor for examination and certification;
  - special "control" the first 30 days after certification (the driver is alone).
- After the initial training and certification, the drivers are given 1 to 2 days refresher training each year.

EMERGENCY PROCEDURES

If the controller (dispatcher) notes that the train has stopped without reason and no contact with the driver can be established for 30 minutes, an emergency is assumed and the driver is presumed sick or injured. Assistance (road vehicle, engine or helicopter) is dispatched for evacuation. The choice of road vehicle, engine or helicopter is based upon the distance and the accessibility of the train.

The track on the Swedish side of the border is generally accessible by road. There are long stretches of remote and isolated tracks on the Norwegian side of the Kiruna-Narvik section.

At emergency stops, in case of air-brake failures, the drivers are required to follow specific procedures for application of hand brakes.

GENERAL EXPERIENCE WITH ONE-PERSON OPERATIONS

Safety

The safety record is excellent and there is no reason to believe that two persons in the cab improves safety.

Remote intervention

Intervention to support the driver en route is occasionally required to remove and sideline disabled and damaged cars. However, such instances are infrequent (say 15 to 20 occurrences per year). Generally, assistance is provided by a meeting train.

It is rare that a driver needs relief or assistance en route due to sickness or injury.

Resistance to one-person operations

The drivers were initially opposed to the concept. The system is now widely accepted and the drivers are earning more.

CONTACT PERSONS

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FIGURE 1
ORE LINE – LOCATION

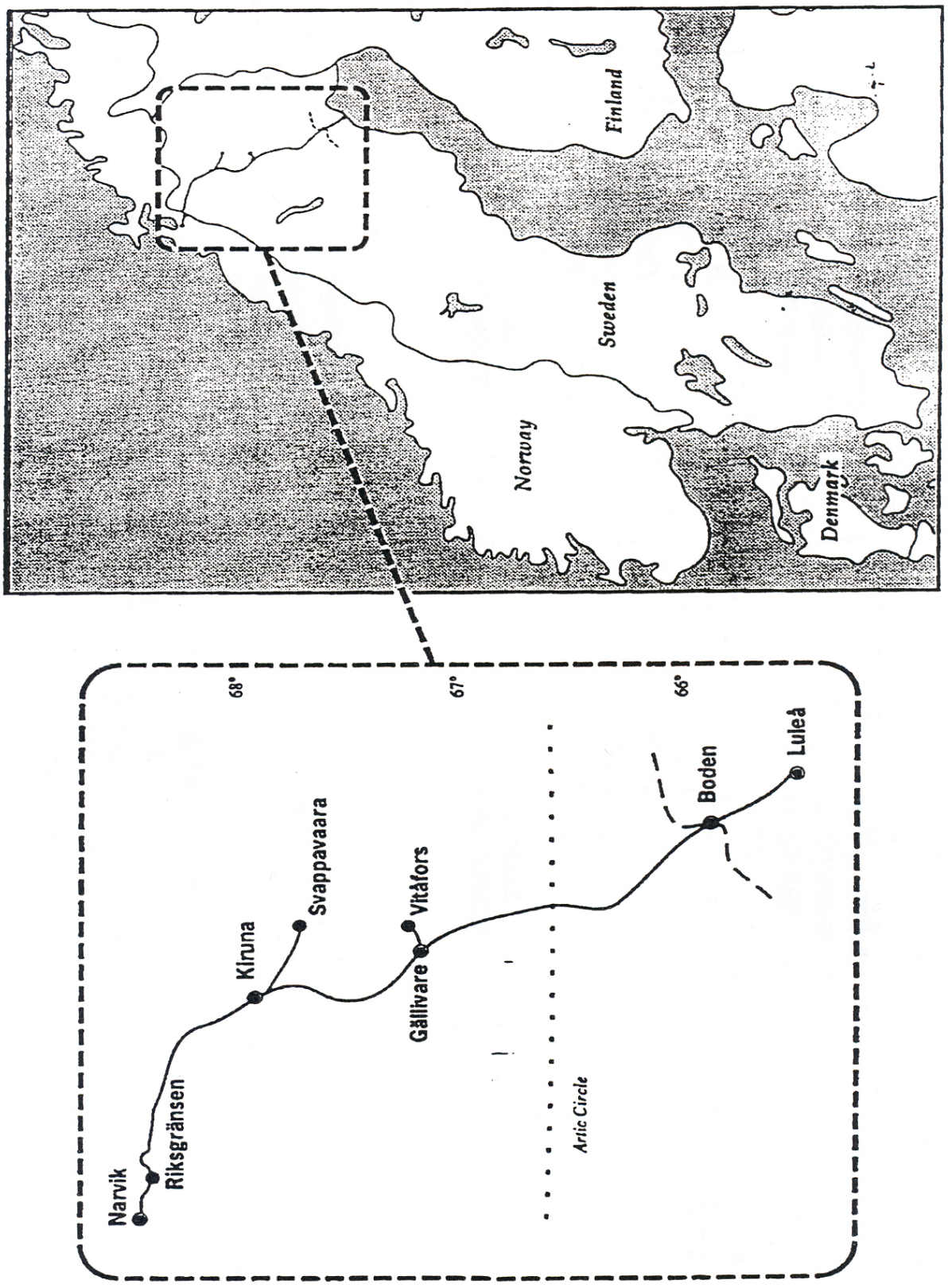
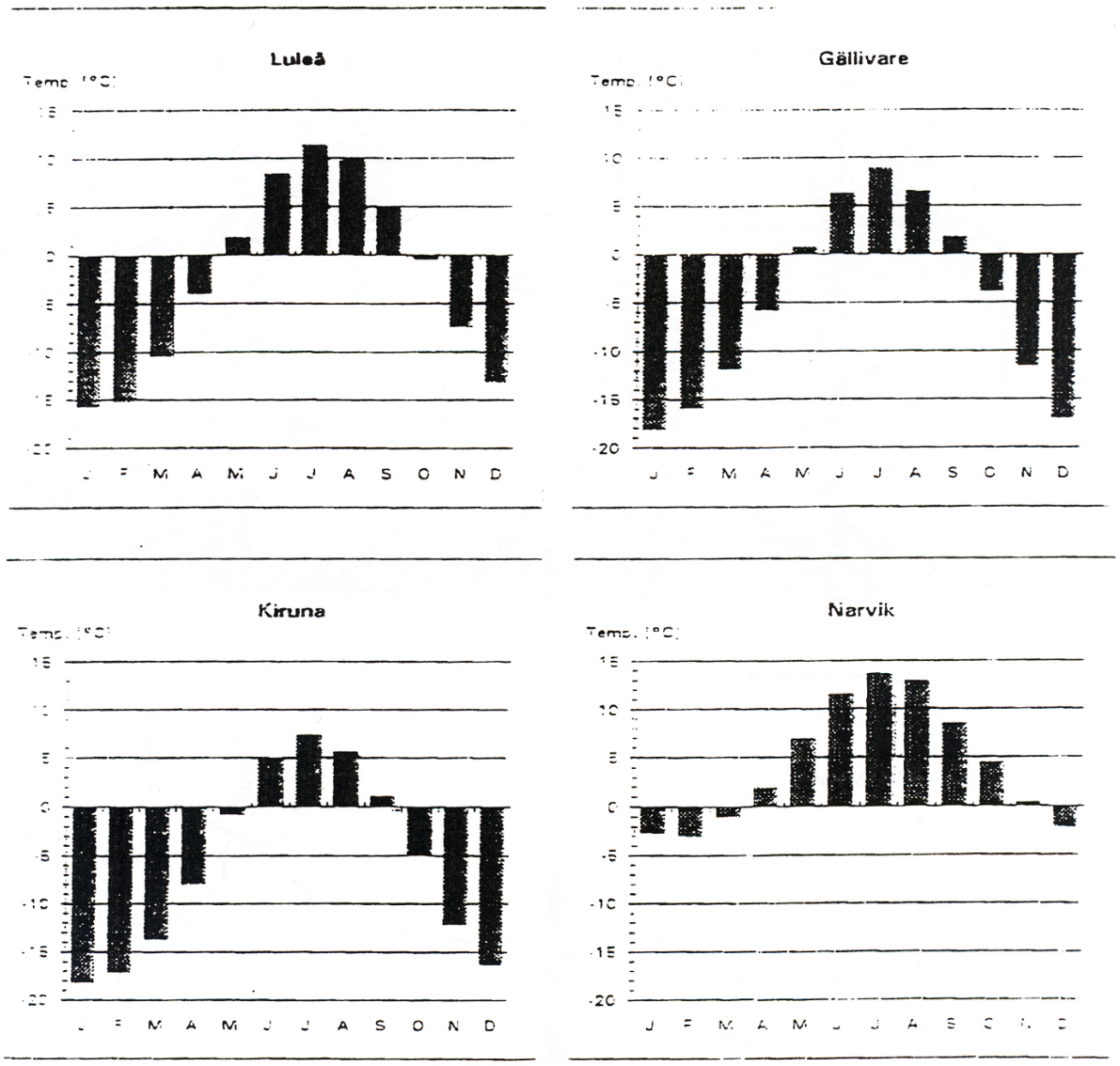


FIGURE 2
ORE LINE – CLIMATIC DATA: MONTHLY AVERAGE TEMPERATURES



The values above are obtained as average temperatures measured during the following periods

Luleå	1961-1993
Gällivare	1972-1990
Kiruna	1961-1993
Narvik	1984-1993

FIGURE 3
ORE LINE – CLIMATIC DATA: DURATION OF SNOW COVER

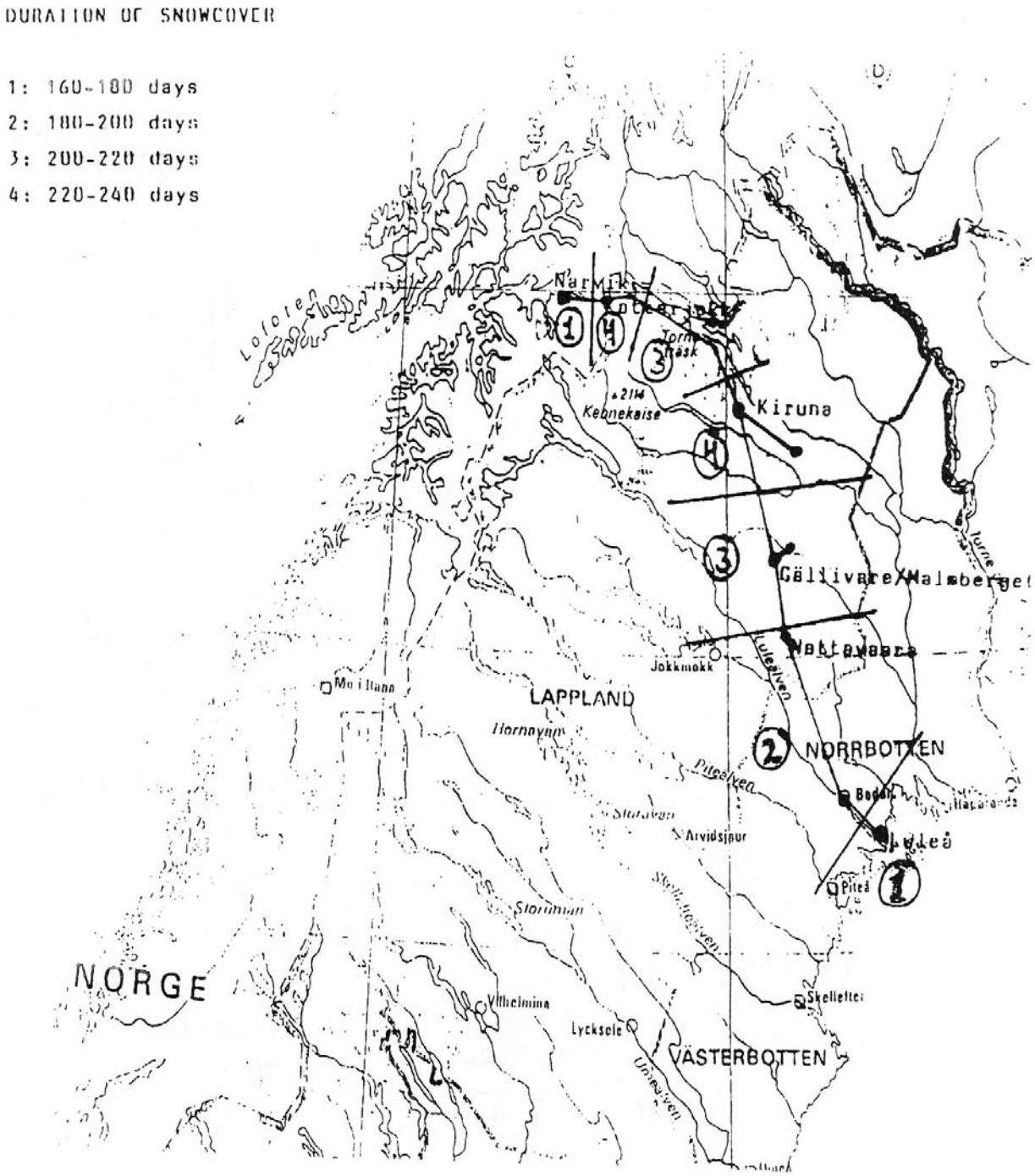


FIGURE 4
ORE LINE – CLIMATIC DATA: THICKNESS OF SNOW COVER

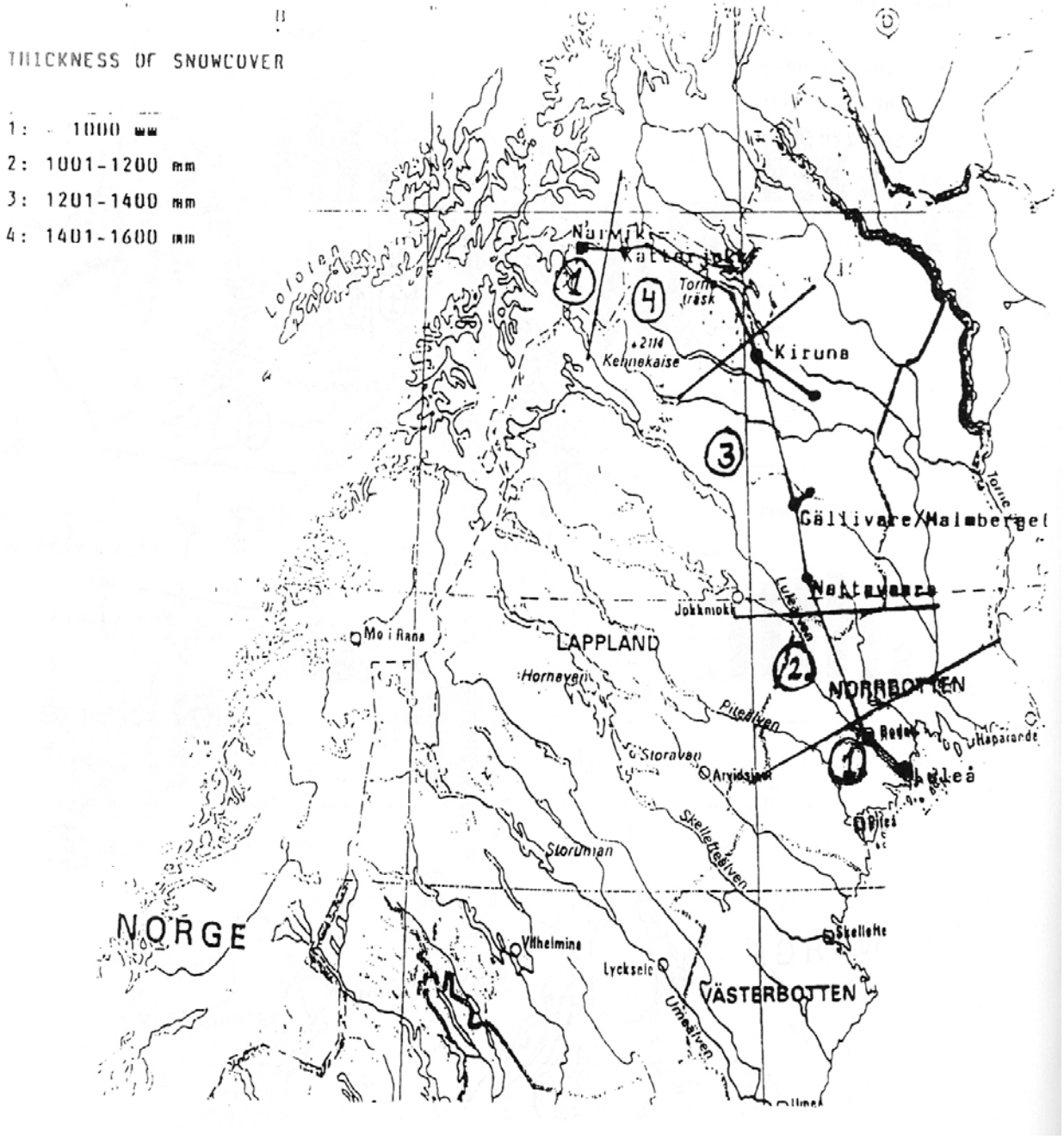


FIGURE 5
ORE LINE – TRACK ALIGNMENT DATA: GRADIENT PROFIL
FOR KIRUNA NARVIK LINE

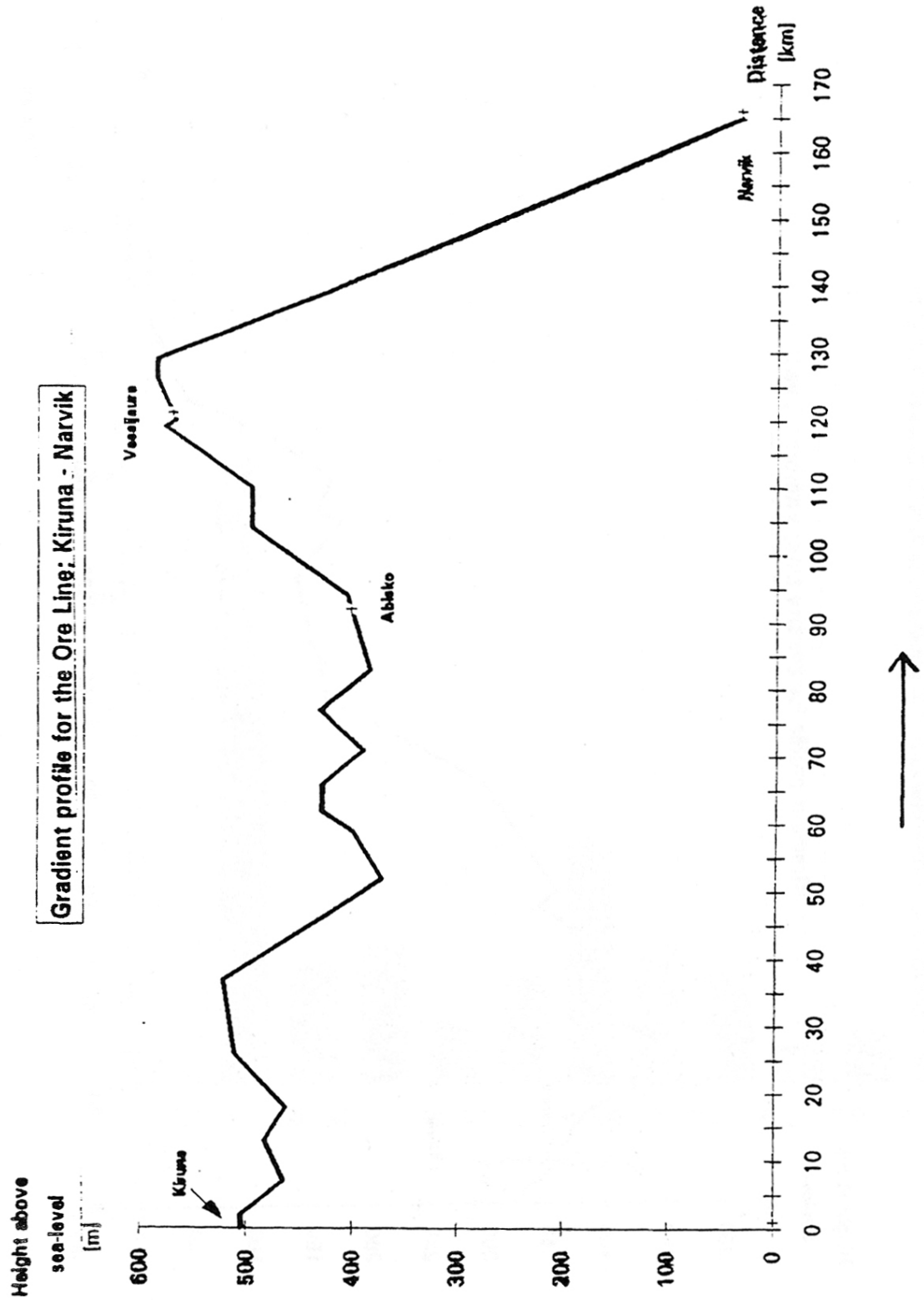


FIGURE 6
ORE LINE – TRACK ALIGNMENT DATA: GRADIENT PROFIL
FOR VITAFORS LULEA LINE

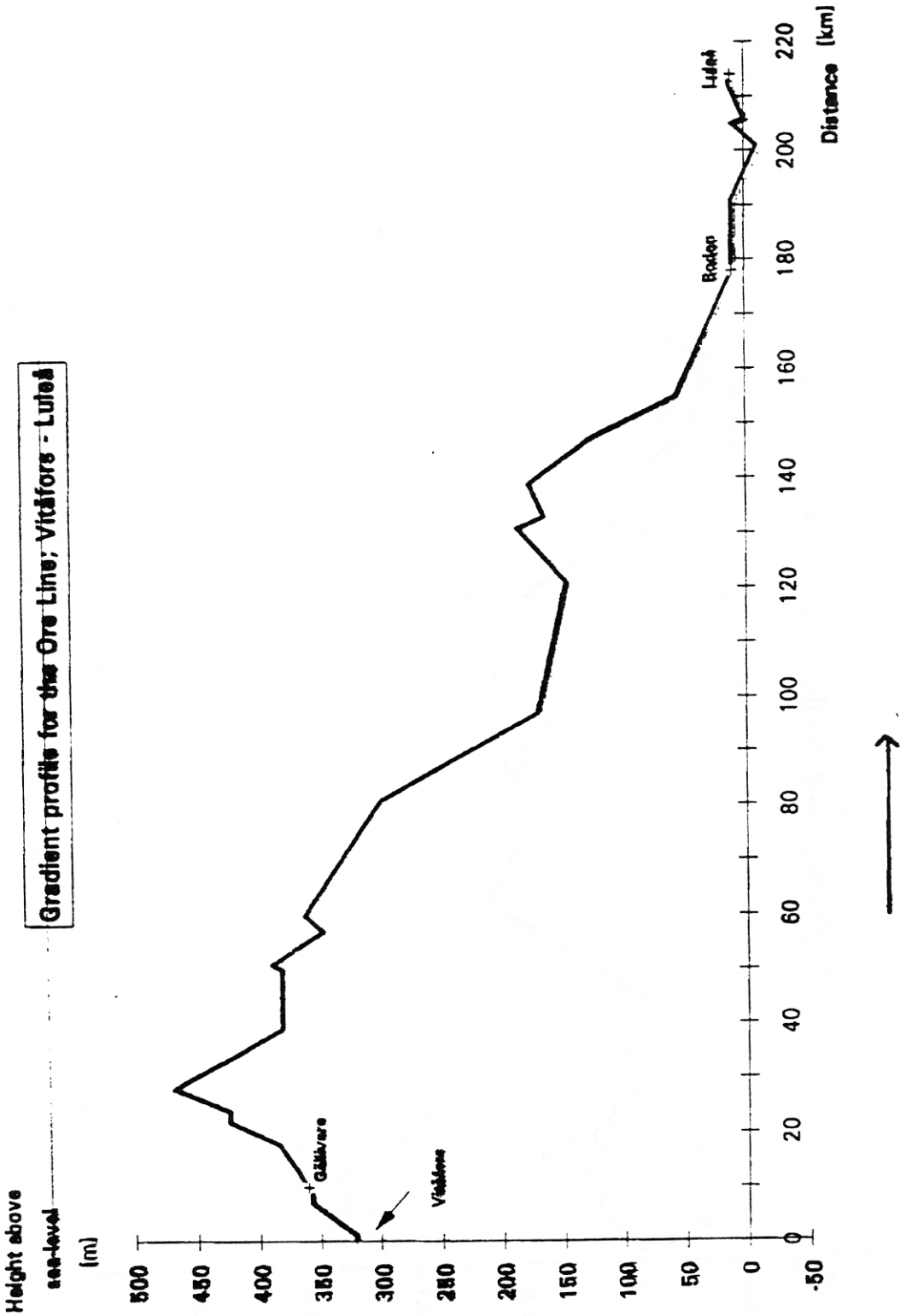


FIGURE 7
ORE LINE – TRACK ALIGNMENT DATA: CURVE DISTRIBUTION
FOR NARVIK RIKSGRANSEN LINE

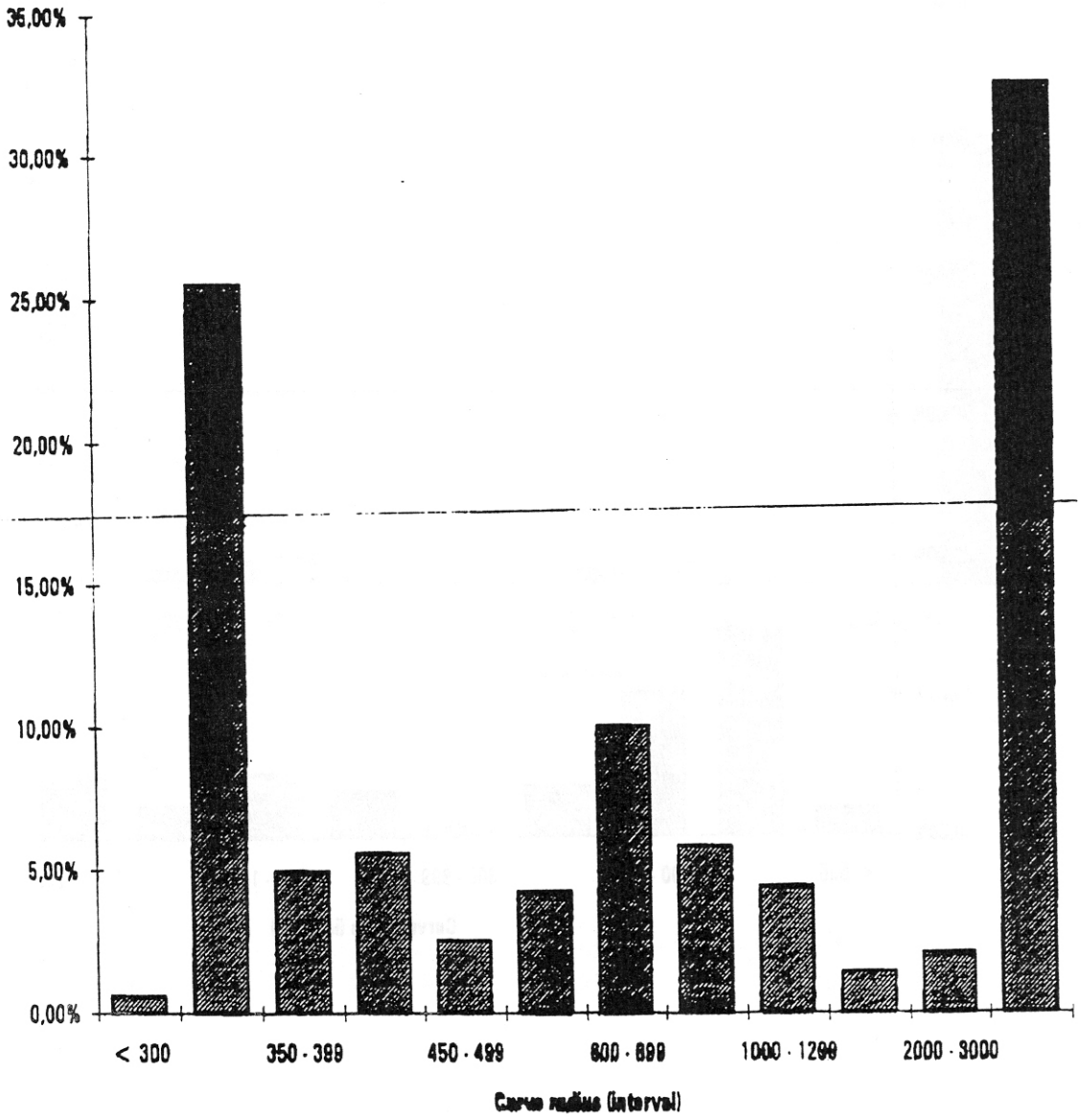


FIGURE 8
ORE LINE – TRACK ALIGNMENT DATA: CURVE DISTRIBUTION
FOR RIKSGRANSEN KIRUNA LINE

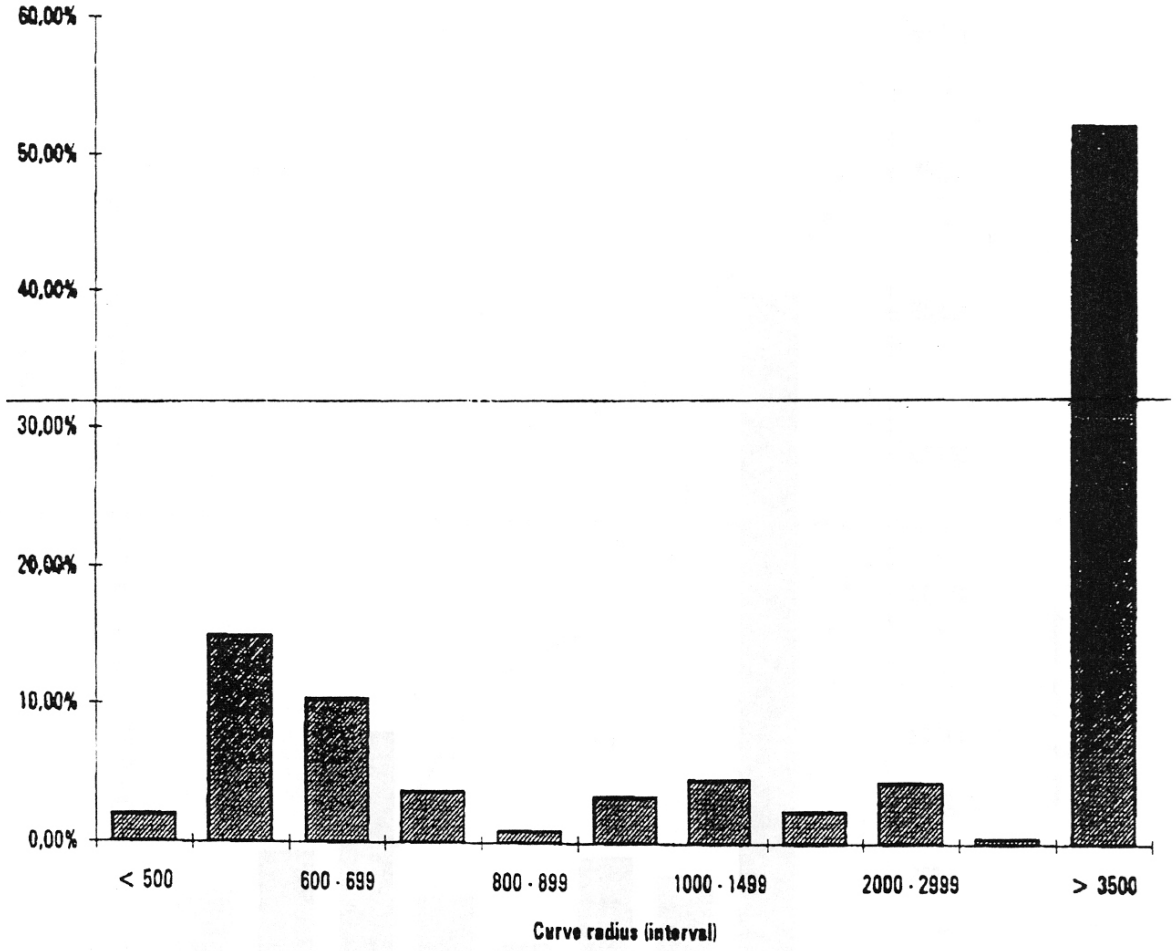
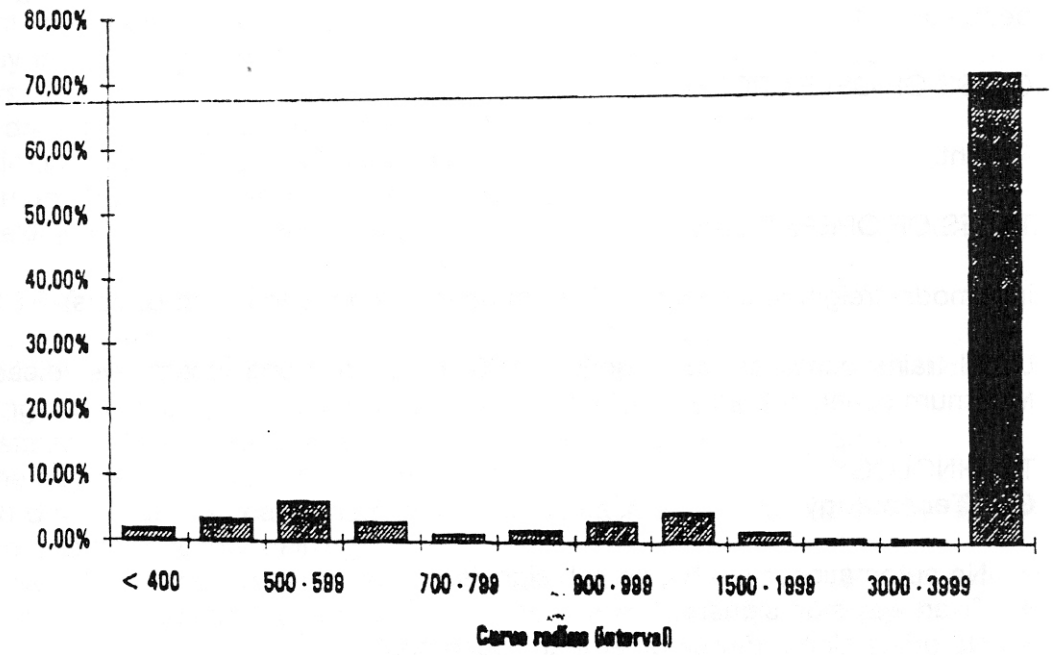


FIGURE 9
ORE LINE – TRACK ALIGNMENT DATA: CURVE DISTRIBUTION
FOR VITAFORS LULEA LINE



5.1.2 ***Freight Liner Ltd. (U.K.)***

All trains are one-person operations except in emergencies, extraordinary conditions and when excess hour work is required. The one-person operation was initiated in 1988-89 and completed by 1990.

Freight Liner Ltd. owns and operates railway rolling stock and road vehicles for transportation of containers. It is a single product, *Containers Only* business.

Freight Liner Ltd. transports containers from deep-sea ports to inland customers and provides truly intermodal service with a company-owned truck fleet and container trains.

Freight Liner does not carry any freight other than containers such as wagon loads, ore, petroleum, etc.

CLASS OF OPERATIONS

Freight.

TYPES OF OPERATIONS

Intermodal freight (containers only from deep-sea ports to inland depots).

Usual trains comprise 25 wagons, 1 800 gross, and one locomotive, diesel or electric. Maximum speed 120 km/h.

TECHNOLOGY
Cab Technology

- No automation, no ATC, no cab signals;
- Fixed, way-side signals;
- No driver alerter device other than “Deadman”;
- AWS (Automatic Warning System) in the cab. AWS provides audio and visual signals to the driver as he passes way-side signals. The visual signal is a “sunflower” in the cab, which changes colour according to the signal aspect. The audio signal is a bell as the locomotive passes a green and a horn as it passes a caution signal. The driver must respond to caution signals by pressing a button. Failure to press the button results in automatic braking of the train.

Communication System

Locomotives are equipped with only a cab radio called the NRN (National Railway Network) Radio. The driver can use this radio to contact the signal man.

In addition to the cab radio, each signal post has a telephone hooked directly to the signal man. This arrangement usually provides access to a telephone within a mile.

DRIVER'S TASKS

- Drive train, observe signals and speeds, and manage acceleration and braking;
- Observe timetable;
- Observe safety rules;
- Protect train;
- Take action in emergencies;
- React to AWS warnings.

DRIVER'S SCHEDULE

- Drivers work on a "balanced roster." Accordingly, over a specified number of weeks, the average number of duty hours for each driver is 37. In any given week, however, a driver might work as many as 50 hours;
- A day is a maximum of 10 hours of running time plus 1 hour of break for a total of 11 hours;
- The drivers are allowed a minimum of 12 hours between shifts;
- Maximum running hours without break are 5;
- Minimum break after 5-hour run is 45 minutes;
- A maximum day can be a 5-hour run + 1-hour break + 5-hour run = 11-hour day

DRIVER TRAINING

- All drivers are given initial training. Training duration is approximately 18 months;
- During training, drivers are tested on a "COMPETENCE MODEL";
- Satisfactory drivers are certified for train service and assigned to depots;
- At the depots, they are given route training;
- Each driver must run each route at least once each 25 weeks. Otherwise, the driver is given a route refresher training;
- A Driver Standards Inspector travels with the drivers at least twice each year. Where problems are identified, the inspector travels with the driver more frequently.

EMERGENCY PROCEDURES

- Drivers are trained in procedures to protect the train;
- The signal man knows the train's location (track circuits);
- In case of emergency, the driver, through the signal man, starts emergency action;
- If communication with the driver breaks down (sickness, injury, etc.) signal man can start emergency procedures;
- Ambulance, fire vehicles, relief vehicles, etc. are dispatched to the emergency scene;
- There is hardly any isolated or inaccessible location in the U.K.

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5.2 **Freight and Passenger Railways**

5.2.1 ***Danish State Railway (DSB – Denmark)***

Danish State Railway operates both freight and passenger trains. All trains have only one person in the locomotive. However, with the exception of suburban trains, all passenger trains have other crew on board comprising one guard and passenger service personnel. The service crew have no role in the running of the train. The guard's role is limited to passenger security, manipulating and securing doors, and signaling the driver to start the train at passenger stops when it is safe to do so.

CLASS OF OPERATIONS

Freight and passenger trains.

TYPES OF OPERATIONS

Freight: Ninety-five percent of freight trains are mixed freight. Freight trains have one locomotive, are a maximum of 2 000 metres long, and weigh 2 200 gross. Freight train speeds are in the range of 100 km/h with a maximum speed of 120 km/h.

Passenger: Passenger trains include suburban trains (S-trains), regional trains, intercity trains, and long distance trains. With the exception of S-trains, all trains have one guard on board the train for passenger security. Intercity and long distance trains also have passenger service crew on board.

Passenger trains usually comprise 1 locomotive and 10 cars. Traction is electric and diesel electric. Passenger train speeds are in the range of 120 to 140 km/h. Maximum travel distance on the DSB is about 600 km and takes about 9 hours.

TECHNOLOGY

Cab Technology

The locomotives are equipped with driver alerters which require that the driver must touch certain objects on the dash-board at least once every 20 seconds. The locomotives are also equipped with ATC. The ATC enforces signals and track speeds. The ATCS tells the driver the maximum distance he can travel at the current speed in view of the status of the track ahead, and prompts the driver to adjust speed. The system intervenes should the driver fail to respond.

Communication System

Locomotives are equipped with radio telephones which permit communication with the dispatcher. The dispatcher dials in the train number. The signal and the ATC systems continuously inform the driver of the track density ahead (for example, two green signals indicate that there are two free blocks ahead, one green signal indicates that only one block is free, and a red signal indicates that the next block is occupied). Traffic control is through CTC. Two dispatchers control most of the railway. The network is fully track-circuited.

Brake System

DSB trains are equipped with air brakes, electropneumatic brakes, and electro-magnetic brakes.

DRIVER'S TASKS

The driver is responsible for operation and security of the train. If problems arise en route, the driver is required to leave the cab, inspect and rectify the problem, and request assistance if necessary. The driver is required to assess the situation if an emergency arises and seek assistance when necessary.

DRIVER'S SCHEDULE

- Maximum shift: 7 hours
- Hours per week: 35 hours (5 shifts of 7 hours)
- Maximum duty hours between breaks: 4 hours
- Minimum break: 30 minutes
- Minimum break between shifts: 11 hours

The drivers are provided washing and eating facilities outside the locomotives during breaks. Location for the breaks is arranged to make these facilities available.

Sixty percent of the drivers know their schedules as much as six months in advance. The others may not know their schedules more than 5 days ahead.

DRIVER TRAINING

A 13-month training period followed by examinations and certification qualifies the drivers for over the road train operations. Following initial certification, the drivers are re-examined every second year. If found deficient in any area, the driver is withdrawn from road service until the deficiency can be rectified. Repeated failure to correct the deficiency can result in de-certification of the driver and withdrawal from driving duty.

Drivers for training are recruited from within the railway and are generally drivers with experience in suburban train operations. These drivers are then given an additional 7 months training for over the road train operations.

A shorter, 6-month training program qualifies the drives to operate S-trains.

EMERGENCY PROCEDURES

There are no remote or inaccessible areas on the railway and therefore emergency situations are easily managed. The drivers are trained in emergency procedures and seek help when an emergency arises. On the other hand, if the "deadman" stops the train and the driver fails to respond to calls from the controller, a physical check is ordered.

The drivers use hand brakes and track circuit clips to secure the train at emergency stops en route. No survival equipment is carried on board.

CONTACT PERSONS
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5.2.2 ***Tranzrail (New Zealand)***

Most Tranzrail freight trains are driver-only operations and more than 90 percent of all trains – passenger and freight – have only one person in the loco cab (called Alternative Train Crewing or ATC). On some secondary routes, however, the railway finds it is more economical to operate with two-person crews than to install a full and continuous radio communication system necessary for one-person operation. A one-person operation is not permitted in areas where full and continuous radio communication is not available. There is no other restriction on one-person operation such as weight or speed limits or transport of hazardous materials.

In many of the shunting operations in many yards, Tranzrail operates remote controlled locomotives.

Tranzrail operates commuter trains, intercity passenger trains, and industrial, mixed, intermodal and heavy haul freight trains. An average freight train comprises the equivalent of 60 boogies (4 axle cars) and one locomotive, and hauls 800 to 900 metric. On some grades, 2 to 3 locomotives may be required. In the high range, heavy haul trains may reach 1 500 to 2 000 metric.

Axle loads are 16 to 18 and are expected to be raised to 22½. Maximum freight train speeds are 90 to 100 km/h for express goods and 60 km/h for ordinary goods. Maximum passenger train speeds are 100 km/h. Traction is electric and diesel electric.

Tranzrail is a 1 068 m (3 ft. 6 in.) gauge system.

CLASS OF OPERATIONS

Freight and passenger trains.

TYPES OF OPERATIONS

Passenger: Commuter and intercity trains
Freight: Freight liners, express goods, slow goods trains and heavy haul trains to transport logs, coal and steel, etc.

TECHNOLOGY

Cab technology

The engines are equipped with a vigilance device. The device requires the driver to touch any of a number of objects once every 50 to 60 seconds. A light comes on if the driver fails to do so, which the driver must cancel within 5 to 10 seconds. Failure to cancel the light sounds an alarm. Brakes are applied if the driver fails to respond to the alarm.

The engines are also equipped with a dead-end monitor which functions in conjunction with the tail and monitor.

A new seat has been installed in the driving position and the forward cab windows have been modified for better visibility.

Many locomotives are equipped with ditch lights which are activated by the driver in potentially hazardous situations, such as at grade crossings. The railway's policy is to eventually fit all the locomotives with ditch lights.

The engines are not equipped with cab signals, advanced warning systems, or automatic control systems.

Communication System

The cab is equipped with a cab radio and a portable radio which permits continuous communication with the dispatcher.

The driver must carry a portable radio when it is necessary to leave the cab en route. As the portable is drawn from its holder, the dispatcher is alerted. Each seven (7) minutes thereafter the driver must press a button on the portable to remain in contact with the dispatcher. If the communication is broken for more than 7 minutes, an automatic device alerts the dispatcher, who initiates emergency procedures.

The drivers are generally aware of other trains in their vicinity via open radio communication by listening to communications between the trains and the dispatcher.

Brake System

The trains are equipped with air brakes.

DRIVER'S TASKS

If a problem develops with the train en route, the driver is required to stop and walk the train to identify the problem. Assistance is sent where switching needs are identified.

While outside the cab the driver must send a signal to an automatic device in the control room by pressing a button on a portable radio he carries with him. If communication is broken for more than 7 minutes, the automatic device alerts the dispatcher who initiates emergency procedures.

DRIVER'S SCHEDULE

The drivers are rostered to work in shifts, for a maximum of 80 hours in two weeks. The shift lengths vary between 10 and 11 hours and the driving (foot plate) times vary between 8.5 and 9.5 hours. The variations are according the following rule:

Shift starts Between – hrs	Maximum Shift length – hrs	Length of driving Time - hrs
16:00 and 5:00	10.0	8.5
5:00 and 7:00	10.5	9.0
7:00 and 14:00	11.0	9.5

The drivers are allowed a 30-minute break halfway through the shifts. During the break, the drivers are encouraged to leave the cab, eat, drink tea or coffee, and take a nap when possible.

The break is taken at the driver's discretion and the railway does not object if the break is not taken.

A minimum break of 10 hours between two shifts is mandatory.

The shift length may be extended in case of train delay. The extended shift during the daylight, however, may not exceed 11.5 hours. Usually the driver is relieved and replaced after 11 hours of duty.

Crew scheduling is done centrally and the drivers usually know their schedules 10 days in advance. But the crew scheduling can change, and when the changes are made on short notice the drivers are consulted.

The drivers remain in telephone communication with the dispatcher and if they feel unable to come to work and safely complete the shift they are required to so inform the dispatcher.

DRIVER TRAINING

Two-day training courses were given to all one-person drivers on new operating rules and on the new radio communication system which was introduced for one-person operation. The new rules and procedures have since been merged into the new operating handbook. Besides the two-day special one-person operation course, Tranzrail has not had to train drivers for several years.

A new driver training program is presently being developed which will be operative in 1997.

Tranzrail is also developing a crew alertness education program which will educate drivers on the functioning of the human body and on how to organize work and sleep, etc. Initially, the program will be given to the drivers and later may be extended to all shift workers. The alertness education program is being developed by Professor Philippa Gander of the U.S. who has already developed similar programs for American airline crews.

EMERGENCY PROCEDURE

Locomotive cabs are equipped with an emergency alert button which sends a priority signal to the dispatcher. The driver can invoke an emergency by pushing the button. Alternatively, if the alerter in the locomotive goes full cycle and applies the brakes, the dispatcher is alerted and emergency procedures are initiated.

Emergency assistance is usually provided by an inspection vehicle or another engine.

There are several areas on Tranzrail which may be considered remote or isolated. However, driver survival equipment is not considered necessary except on the Midland Line on the South Island due to mountainous terrain, cold weather, snow, and storms. The equipment provided is a survival blanket suitable for Antarctic weather. Wooden chocks are also carried on board the Midland Line trains which may be applied, in addition to hand brakes, to secure the train at emergency stops.

CONTACT PERSONS

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5.2.3 ***Swedish State Railway (Sweden)***

The Swedish State Railway operates both freight and passenger trains. All freight and passenger trains are operated with only one person in the locomotive. Most passenger trains, especially intercity and long distance trains have other crew on board for passenger service and security. These cabin crews, however, are not employed on local and suburban trains where the passenger equipment permits the driver to operate, lock and monitor the passenger doors. Such capability is provided on multiple unit cars where the driver has full control of the doors.

Swedish State Railway operating procedures are similar to those of the Ore Line discussed earlier, which was part of the Swedish State Railway until recently. The Swedish State Railway does not operate heavy haul trains of the type run by the Ore Line.

CLASS OF OPERATIONS

Freight and passenger trains.

TYPES OF TRAINS

Passenger: Intercity, local, regional, suburban

Freight: All types of freight trains except heavy haul.

Passenger train speeds are in the range of 160 to 200 km/h, and freight train speeds are in the range of 100 to 120 km/h.

OTHER OPERATING CHARATERISTICS AND SAFETY MEASURES

Please see the section on Ore Line.

CONTACT PERSONS

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5.2.4 *English Welsh and Scottish Railway (U.K.)*

EWS uses one-person operation extensively. Sixty to seventy percent of their operations are with only one person on the “footplate.”

CLASS OF OPERATIONS

Freight and passenger trains.

TYPES OF TRAINS

Passenger: Class 1 trains only such as mail trains

Freight: Heavy haul trains carrying petroleum, timber and aggregate, container trains, mixed freight and LWL (less than wagon load) trains, and block trains (one product, one customer).

The freight trains may be 2 500 feet long comprising 50 to 60 wagons and 2 locomotives and gross weight of 3 000 tonnes.

TECHNOLOGY

Cab technology

A driver safety device which the driver cannot neutralize while in motion is mandatory. The device is called AWS (Automatic Warning System), which comprises a “sunflower,” a bell and a horn. The horn sounds and the sunflower turns yellow for restrictive or caution signals. The driver must acknowledge the restriction by pressing a button. Failure to do so results in automatic braking of the train. Application of brake automatically cuts off traction.

The AWS is a transponder-based system. A high proportion of British Rail network is fitted with AWS.

Communication System

A radio communication system which provides continuous and direct speech communication between the driver and the controller or the controlling signal box Is recommended but not essential.

However, when operating with only one person over passenger lines, the driver must be provided with either the communication system described above or a telephone connecting with the controlling signal box every 2 miles along the line.

Brake System

Automatic air or vacuum brake system must be operative throughout the train for one-person operations.

DRIVER'S TASKS

The drivers are required to deal with emergencies en route which might affect safe operation of trains. The drivers may have to leave the cab to inspect the train and assess and rectify problems.

The driver must advise the signalman when leaving the cab. After leaving the cab, the driver is subject to a "10-minute rule," which requires that the driver must return to the cab within 10 minutes and request help if the problem is not fixed.

DRIVER'S SCHEDULE

- Normal shift: 7 to 9 hours
- Hours per week: 35 to 45 hours (5 shifts of 7 hours to 5 shifts of 9 hours)
- Driving hours between breaks: 3½ hours
- Minimum break: 30 minutes

- When driving hours between breaks are expected to exceed the limit, a second person is placed in the cab;

- Duration between breaks and the length of break are according to agreement between the drivers and the railway;

- The drivers work on an 8-week schedule cycle and usually know their schedules a minimum of 8 weeks in advance.

DRIVER TRAINING

The drivers are trained in two stages. Initially they are trained to be “trainmen” to acquire basic skills. Driver training follows.

Driver competence assessment, called safety critical assessment, is done on a two-year cycle.

Beside initial training and two-year cycle critical safety assessments:

- Safety briefings for the drivers are held every 12 weeks.
- Train crew digests are issued periodically on an ad hoc basis, usually about 20 issues per year.
- Weekly operations notices (WON) containing information on changes to signaling and equipment over a given line, and safety instructions, are issued.

During early stages of one-person operations, the driver training was refocused on one-person rules.

EMERGENCY PROCEDURES

The trains are under the control of the signalman. The driver can request emergency assistance. On the other hand, if the train is delayed or stopped en route and the driver cannot be contacted, assistance is usually provided by a meeting train in the vicinity. Special assistance is sent when necessary.

Emergency equipment on board

The driver carries a portable first aid kit. In addition, there are also red lamps, red flags, chocks and detonators to secure the train during emergency stops.

Remote and isolated areas

There are no remote or isolated areas in the region.

RESTRICTIONS ON ONE-PERSON OPERATIONS
Tracks

One-person trains may be operated only:

- over single line and freight lines not adjacent to passenger lines;
- over passenger lines which are continuously circuited and signaled and the driver is provided with continuous and direct speech radio communication with a controller or controlling signal box, or there is a telephone connecting with the controlling signal box every two miles;

- over lines adjacent to continuously circuited passenger lines described above;

- over lines adjacent to passenger tracks which are non-circuited and where the communication system may be deficient provided the travel distance does not exceed 10 miles.

Vehicle types

Certain vehicle types such as 2- or 3-axle service vehicles without appropriate brakes, hopper cars 24/75t, may not be operated as one-person trains.

Traffic

One-person trains are not permitted for transport of toxic gases, radioactive substances, hydrocyanic acid and trains comprising more than one wagon or container of flammable gases.

GENERAL EXPERIENCE WITH ONE-PERSON OPERATIONS

EWSR's 10 years experience with one-person operations has been positive with respect to safety and adherence to operating rules.

CONTACT PERSONS

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5.2.5 *Deutsche Bahn AG (DB AG – Germany Railway)*

In the trains operated by the Deutsche Bahn AG (DB AG) the operating traction unit is occupied during the journey by just one driver (engineer); traction units controlled from another unit may remain unoccupied. When a trailing traction unit is controlled from another leading unit, the driver must be at the head of the train.

A second crew member – driver's assistant – is required in the leading unit if certain technical safety systems, e.g. the driver's safety device (DSD) (deadman's handle) are malfunctioning.

As a rule, passenger trains additionally carry at least one conductor. Passenger trains may also operate with just a driver if certain conditions are met, e.g. the train must not be longer than a certain length, technical visual aids must be provided on the station platforms, apparatus for monitoring the outer doors must be provided in the driver's cab, etc.

CLASS OF OPERATIONS

Freight and passenger trains.

DRIVER'S SCHEDULE

Drivers work shifts of widely varying durations in widely varying locations ("alternating shifts"). The rules for planning working hours are laid down in a document known as the "Working Hours Regulations".

The decisive factor for the operation of a train is the driving time scheduled to be spent in the traction unit during a particular work shift. The distances (number of kilometres travelled on the routes) are irrelevant. The following applies:

Maximum overall time that may be accumulated driving a train during one working day (work shift):

- Trains with a speed of more than 80 km/h — 7 hours
- Trains with a speed of less than 80 km/h — 8 hours
- Shunting duty — 9 hours
- Simple conditions (e.g. work trains) — 10 hours
- Extension of scheduled driving time — 1 hour (max.)

The total duration of the breaks taken during the shift must be at least 1 hour, and one of the breaks should be at least 30 minutes long.

The driver's shift is always symmetrically arranged, i.e. the place where the shift starts is the place where the shift ends.

The minimum rest period for a driver between 2 shifts at an out-of-town location must be at least 5 hours.

The break is governed by the following rules:

- duration basically at least 30 minutes, or 2 x 15 minutes
- deviations from this stipulation are possible if;
  - the work shift is less than 6 hours;
  - having regard to the activities to be performed, the driver can recover in another way (e.g. during periods when work is suspended because he must wait for other staff to complete their duties).

Maximum continuous periods of time during which a driver may operate the traction unit in main-line service is 5.5 hours and the driving time is deemed to have been interrupted if the break period lasts at least 10 minutes.

The normal maximum length of a working day is 10 hours and may be extended to 12 hours. If a 2-hour break has been taken during the shift, the length of the working day may be extended to a maximum of 14 hours.

Total working time is 38.5 hours per week; on average during a timetable period (June to May of the following year) a driver may not be required to work more than 5.25 days (shift) in a week.

5.3 Passenger Only Railways

5.3.1 *Amtrak (U.S.)*

Amtrak operates with one driver only in the engine on the Harrisburg-Washington-New York-New Haven-Boston section of the Northeast Corridor. There are other crews on board the train for passenger service and safety.

CLASS OF OPERATIONS

Passenger.

TYPES OF OPERATIONS

Intercity (commuter operations not studied). Current speeds are 200 km/h and are expected to increase to 240 km/h by the year 2000.

TECHNOLOGY

Cab Technology

- Four-aspect cab signal, being upgraded to nine-aspect cab signal to permit higher speed;
- Driver alerter in cabs (sounds warning if senses that driver is not alert);
- For speeds greater than 126 km/h, engines are equipped with signal speed enforcers;
- For speeds greater than 200 km/h, engines are equipped with track speed enforcers.

Communication System

- Working locomotive radio;
- Each train service crew has a portable radio;
- If engine radio fails, one of the crew member provides a portable radio to the driver.

DRIVER'S TASK

Same as for two-person engine crew. There are no extra tasks.

DRIVERS SCHEDULE

- 9 to 10 hours working day;
- 5-day week;
- Maximum run for one-driver operation without break is 4 hours. When the run is more than 4 hours, 2 drivers take turns at the throttle.

CONTACT PERSONS

Bill Autro, Operations
Tel.: (215) 349-1699

5.3.2 *Great North Eastern Railway (U.K.)*

GNER operated passenger trains from London to Scotland with one driver only. There is other crew on board comprising one guard and cabin catering crew.

CLASS OF OPERATIONS

Passenger.

TYPES OF OPERATIONS

- Intercity passenger trains: London to Scotland;
- Run ± 500 miles
- Train speed are 200 km/h (GNER used to assign 2 drivers for speeds more than 176 km/h. Since privatisation in October 1995, the 176 km/h speed limit for one driver has been removed).

DRIVER SCHEDULE

- Driver changes at New Castle after 300 miles and 3 hours' run
- Driver takes a break at New Castle and brings another train back to London;
- Minimum break: 30 minutes;
- Maximum work duration between breaks: 5 hours;
- Maximum day: 8 hours;
- Maximum week: 37 hours.

CONTACT PERSONS

Peter Fisher
Duty Operations Manager
Tel.: +44-190-465-3022
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John Naisby
Driver Manager
Tel.: +44-190-452-2085

APPENDIX
SUMMARY OF CONTACTS

APPENDIX

SUMMARY OF CONTACTS

Information provided by the following railways is gratefully acknowledged. The following officials may be contacted for further information or discussions.

Railway	Contact person	Telephone number
Amtrak (U.S.)	Bill Antro Operations	Tel: (215) 349-1699
Danish State Railway (Denmark)	Carl Johan Rosengren DSB Rolling Stock	Tel: +45 33 140400 ext 12102 Fax: +45 33 140440
Deutsche Bahn AG (DB AG-German Railway)	Herr Shruder (Freight) Herr Rockenfelf (Traction)	Tel: (069) 97-33-14237 Fax: (069) 97-33-17541 Tel: (069) 265-27730 Fax: (069) 265-27860
English Welsh and Scottish Railway (U.K.)	Allan MacDonald Traction and Train Crew Manager	Tel: +44 127 0532077 Fax: +44 127 0533369
Freight Liner Ltd. (U.K.)	Eddy Fitzsimons Director of Operations	Tel: +44-171-214-9263 Fax: +44-171-214-9279
Great North Eastern Railway (U.K.)	Peter Fisher Operations Manager John Naisby Driver Manager	Tel: +44 190 465 3022 Fax: +44 190 452 3514 Tel: +44 190 452 2085
Ore Line (Sweden)	Matts Westerlund Manager, Ore Line	Tel: +46-98074100 Fax: +46-98074109
Swedish State Railway (Sweden)	Ulf Palsson	Tel: +44-8-762-3972 Fax: +46-8-762-3775
Tranzrail (new Zealand)	Don Davis, Corporate Manager, Quality and Safety	Tel: +64-4-498-3000 Fax: +64-4-498-2004
Rail Track (U.K.)	Philip Wiltshire Safety and Standards	Tel: +44 1904 52 2000