International Rail Safety Conference

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9300

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Michel Joing

Welcoming Address

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I am delighted to welcome you all to this seminar, organized this year by SNCF's safety delegation.

Safety entails potential risks and benefits which must be properly assessed so that decisions may be taken and justified on a rational basis.

As a group, we represent a remarkable range of experience and knowledge with an emphasis on the exchange of research and best practice in the railway safety field.

I trust that this seminar will contribute to an increased awareness and use of risk assessment, a better understanding of human factor and consequently to enhanced railway safety.

You will find herewith :

- the list of delegates,
- the agenda,
- the proceedings.

I wish you all a successful seminar.

Michel JOING

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List of Delegates

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INTERNATIONAL RAILWAY SAFETY SEMINAR 1993

LIST OF DELEGATES

ANGERS (FRANCE)

LIST OF DELEGATES

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Board Member
British Railways Board

MR M.L.A. SIEBERT
Director Safety
British Railways Board

Mr. David MAIDMENT
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Mr. Hiroshi NAGAOKA
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East Japan Railway Company

Mr. Shigeru NAKAGAWA
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Mr. Osamu YOMONO
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Mr. Jan SWIER
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Dependability Responsible

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AGENDA

ANGERS (FRANCE)

INTERNATIONAL RAILWAY SAFETY SEMINAR 1993

Hôtel Mercure at ANGERS (FRANCE)

Tuesday – October 26th

TIME	NAME	SUBJECT
8.45/9.15		Reception Haarlem Room Palais des Congrès
9.15/9.30	Michel JOING Head of safety studies center SNCF	Welcome – Opening of the seminar
9.30/10.15	Dominique SIMON Deputy Director Region of Nantes SNCF	Presentation of the Nantes region
10.15/10.45	Coffee – Tea – Break at Bar	
10.45/12.45	Theme : Safety related accreditation of railways Chairman : Michel JOING ---	
	Guy HOEDTS Head of European Department International Direction SNCF	Railway safety in European Community legislation
	Toshimasa MURAKAMI Manager of Transport Safety Department East Japan Railway Company	Administrative regulations on railway undertakers
	Ray RYAN Executive Manager New Zealand Rail LTD	Safety management system in NZRL
12.45/14.15	Lunch at the restaurant "Les Saisons"	

INTERNATIONAL RAILWAY SAFETY SEMINAR 1993

Hôtel Mercure at ANGERS (FRANCE)

Tuesday – October 26th

TIME	NAME	SUBJECT
14.15/15.45	Theme : Safety system and risk assessment Chairman : Michel JOING ---	
	David RAYNER Board Member British Railways Board	Safety case Practice
	Hiroshi NAGAOKA Director Safety Research Laboratory East Japan Railway Company	The accident/incident database and risk assessment study at JR East
15.45/16.15	Coffee – Tea – Break at the Bar	
16.15/18.00	Dr Friedel MULKE General Manager Management Support Transnet Limited	A holistic approach to loss control in a metro train service in South Africa
	Joss HENDRIKS Head Railway Safety Department Operations division NV Nederlandse Spoorwegen	Risk analysis method RAM
	Jan STUIFMEEL Staff Operations Division Railway Safety Department NV Nederlandse Spoorwegen	Injuries sustained by passengers due to the malfunctionning of the outer doors of train
18.30/19.30	Reception at the town hall by M. Jean MONNIER Mayor of Angers	

INTERNATIONAL RAILWAY SAFETY SEMINAR 1993

Hôtel Mercure at ANGERS (FRANCE)

Wednesday – October 27th

TIME	NAME	SUBJECT
8.30/10.15	Theme : Safety system and risk assessment (followed) Chairman : Michel JOING ---	
	Lt Cdr. Jack ROSE Safety Assessment Manager London Transport (LTD)	Staff accident safety analysis
	David WHARTON-STREET Human Factors Adviser British Railways	Working hours related with safety
10.15/10.45	Coffee – Tea – Break at the Bar	
	Theme : Human Factors related with Safety	
10.45/12.30	Robert LONCLE Head of Human Factors Unit Personnel Direction – SNCF	Cooperation between SNCF and social science researchers. Example : track workers'safety
	Dr Francine KERAVEL Human Factor Expert Safety Studies Center SNCF	Feedback analysis of human error for a better management of risk
12.30/14.00	Lunch at the restaurant "Les Saisons"	

INTERNATIONAL RAILWAY SAFETY SEMINAR 1993

Hôtel Mercure at ANGERS (FRANCE)

Wednesday – October 27th

TIME	NAME	SUBJECT
14.00/16.00 13h30	Worshop B. – Room 204 Theme : Human Factors related with safety Chairman : Robert LONCLE	
	David MAIDMENT Head Safety Policy Unit British Railways Board	Safety Management Training
	David WHARTON–STREET Human factor Adviser Safety Policy Unit British Railways Sarah TOZER Ergonomist Research Division British Railways	] A proactive system for measuring] organisational safety health] in a railway environnement ("REVIEW")
16.00/16.30	Coffee – Tea – Break at the Bar	
16.30/18.30	François LAPORTE safety management Region Laurentienne Canada National	The necessity of incorporating the cognitive aspects in accident analysis : an example of a bridgeworker accident
	Gérard CHURCHILL Général Management Dependability Responsible RATP	Quantification of safety's jobs at the RATP company
	Hirokazu MIKI Director Working Conditions Department East Japan Railways Workers'Union	Factors of running–over accidents involving subcontractors'workers
19.00/24.00	Evening at the Brissac Castel Reception, visit, dinner	

INTERNATIONAL RAILWAY SAFETY SEMINAR 1993

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Wednesday – October 27th

TIME	NAME	SUBJECT
14.00/16.00	Worshop A. – Room HAARLEM Theme : Audits – Safety statistics Chairman : Michel JOING ---	
	Michael SIEBERT Director Safety British Railways Board	Use of the international safety rating system on a railway
	Russel BLINCO Health and Safety Department Director Via Rail Canada INC	The evolution of safety and loss control in the canadian passenger rail transportation industry
	Gérard CHURCHILL Général Management Dependability Responsible RATP	Dependability Auditing A new fonction in the company
16.00/16.30	Coffee – Tea – Break at the Bar	
16.30/18.30	George LEE Safety Manager Mass Transit Railway Hong Kong	The safety audit system of the Mass Transit Railway of Hong Kong
	Toshimasa MURAKAMI Manager Transport Transport Safety Department East Japan Railway Company	The management of statistics for railway accidents and operation impediments
	David MAIDMENT Head of Safety Policy Unit British Railways Board and Michel JOING Head of Safety Studies Center SNCF	Exchange of safety data between railways
19.00/24.00	Evening at the BRISSAC Castel Reception, visit, dinner	

INTERNATIONAL RAILWAY SAFETY SEMINAR 1993

Hôtel Mercure at ANGERS (FRANCE)

Thursday – October 28th

TIME	NAME	SUBJECT
8.30/10.30	Theme : Risk assessment's studies Chairman : Michel JOING ---	
	François PINTON Operation Expert Safety Studies Center SNCF	Transport of hazardous substances : general risk assessment on SNCF network
	Paul ABBOTT Standards Manager Special operations British Railways	Transport of dangerous substances : Health and safety sub committee A British Rail View
	François LAPORTE Safety Management Région Laurentienne Canada National	. Emergency measures plan . Saint–Léonard d'Aston : a story of communication and cooperation
10.30/11.00	Coffee – Tea – Break at the Bar	
11.00/12.30	David RAYNER Board Member British Railways Board	Evaluation of ATP Benefits
	Bruno COZZI Rolling Stock Expert Safety Studies Center SNCF	The implementation of ATP system on SNCF network
12.30/14.15	Lunch at the restaurant "Les Saisons"	

INTERNATIONAL RAILWAY SAFETY SEMINAR 1993

Hôtel Mercure at ANGERS (FRANCE)

Thursday – October 28th

TIME	NAME	SUBJECT
14.15/15.45	Theme : Risk assessment's studies (followed) Chairman : Michel JOING ---	
	Jan SWIER Technical Staff NV Nederland Spoorwegen	The development of a new level crossings policy in the Netherlands
	Kurt NOLTE Abteilungsleiter Deutsche Bundesbahn	Safety of high speed railway tunnels German experiences of planning and realization of safety measures
15.45/16.15	Coffee – Tea – Break at the Bar	
16.15/17.00	Jean–Louis MEYER Director Safety Delegation General Headquarters SNCF	Evaluation of the seminar Closing speech
17.00	End of Seminar	
17.30/19.30	After the end of the seminar, visit of ANGERS'castle and museum	

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Railway safety in european community legislation — M. HOEDTS (SNCF)

Administrative regulations for railway employers — T. MURAKAMI (EJR)

Safety management system in NZRL — R. RYAN (NZRL)

THEME : Safety system and risk assessment

Safety case practice — D. RAYNER (BR)

The accident/incident database and risk assessment study at JR East — H. NAGAOKA (EJR)

A holistic approach to loss control in a Metro train service in South Africa — Dr. F. MULKE (TRANSNET)

Risk analysis method RAM — J. HENDRIKS (NS)

Injuries sustained by passengers due to the malfunctionning of the outer doors of train — J. STUIFMEEL (NS)

Staff accident safety analysis — J. ROSE (LTD)

Working hours related with safety — D. WHARTON-STREET (BR)

THEME : Human Factors related with safety

Research on human factors : cooperation between SNCF and social sciences researchers. Example : track workers'safety — R. LONCLE (SNCF)

Feedback analysis on human error for a better management of risk — F. KERAVEL (SNCF)

Safety management Training — D. MAIDMENT (BR)

A proactive system for measuring organisational safety health in a railway environnement ("REVIEW") — D. WHARTON-STREET, S. TOZER (BR)

The necessity of incorporating the cognitive aspects in accident analysis : an exemple of a bridgeworker accident	F. LAPORTE (CN)
Quantification of safety's jobs at the RATP company	G. CHURCHILL (RATP)
Factors of running-over accidents involving subcontractor's workers	H. MIKI (JREU)

THEME : Audit – Safety statistics

Use of the international safety rating system on a railway	M. SIEBERT (BR)
The evolution of safety and loss control in the canadian passenger rail transportation industry	R. BLINCO (VR)
Dependability auditing. A new fonction in the company	G. CHURCHILL (RATP)
The safety audit system of the Mass Transit Railway of Hong Kong	G. LEE (MTRC)
The management of statistics for railway accidents and operations impediments	T. MURAKAMI (EJR)
Exchange of Safety data between railways	D. MAIDMENT/M. JOING (BR/SNCF)

THEME : Risk assessment's studies

Transport of hazardous substances : general risk assessment on SNCF network	F. PINTON (SNCF)
Transport of dangerous substances : Health and safety sub committee. A British Rail View	P. ABBOTT (BR)
Emergency measures plan – Saint–Léonard d'Aston : a story of communication and cooperation	F. LAPORTE (CN)
Evaluation of ATP Benefits	D. RAYNER (BR)
The implementation of ATP system on SNCF network	B. COZZI (SNCF)
The Development of a new level crossings policy in the Netherlands	J. SWIER (NS)
Safety of high speed railway tunnels German experiences of planning and realization of safety measures	K. NOLTE (DB)

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Paper 9305

Guy Hoedts

Rail Safety in European Community Legislation

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

RAILWAY SAFETY

IN EUROPEAN COMMUNITY LEGISLATION

Guy HOEDTS

Head of European Department
International Direction
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AE93-269/railsafe.doc 10-06-1993

RAILWAY SAFETY IN EC LEGISLATION

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(<u>THREE PARTS</u> :
(* A brief survey of the working of the EC (1 & 2)
(** Directive 91/440/EEC (2 thru 8)
(*** New developments (9 thru 16)

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1- THE EUROPEAN COMMUNITY

* The Council [of ministers]: the power of decision

* The EC Commission: the monopoly of proposition

* The European Parliament: the right to be consulted

2- THE COMMUNITY "LAWS"

* The European "Regulation"

versus

* The European "Directive"

3- THE "ACCESS" DIRECTIVE

* Council directive 91/440/CEE of July 29, 1991 on the development of Community railways

4- THE OBJECTIVES OF DIRECTIVE 91/440/EEC

* Restoring a sound financial situation for the existing railway companies

* Transcending the national limits of the organisation of railways

* Establishing autonomy of management

5- THE MEANS OF DIRECTIVE 91/440/EEC

* Separation between infrastructure and operations

* Two new concepts:

  - The infrastructure manager

  - The railway undertaking

6- THE THREE KINDS OF SEPARATION

* Mandatory separation of accounts
* Optional organisational separation
* Optional institutional separation ("Swedish model")

7- THE RIGHTS OF ACCESS AND TRANSIT

* For international groupings
* For individual combined transport operators
* The problem of access fees

8- THE INSUFFICIENCIES OF DIRECTIVE 91/440/EEC

* Setting the right infrastructure fees
* Defining the rights and obligations of the new entrants

9- THE NEW DRAFT PROPOSALS OF THE COMMISSION

* Licences for operators
* Charging for infrastructure
* 1 directive, 1 regulation and 1 directive, 2 directives, or -finally- 1 regulation and 1 directive?

10- THE DRAFT DIRECTIVE ON ACCESS TO THE INFRASTRUCTURE

* Diverging national approaches to charging of fees
* Establishing traffic priorities
* Non-financial criteria : safety

11- THE DRAFT DIRECTIVE ON LICENCES

* The various criteria for granting a licence (financial fitness, good repute, professional competence...)
* Operating licence vs access to the profession
* Safety

12- SAFETY IN THE DRAFT DIRECTIVE ON LICENCES

* Access to training (art.7.2)

* Review of criteria one year after issueing the licence and every five years thereafter (art. 9)

* Assessing the requirements at any time if there are "serious doubts"

* Suspending or revoking the licence (art. 10)

* Specific national technical requirements (also safety ?) (art. 11)

13- COUNTERPROPOSALS OF THE RAILWAYS

* Make it a regulation not a directive

* No delegation of training to third parties

* Distinguish between licence and permit to operate a specific service

* Stronger assessment of competence by the infrastructure manager

* Clarify art. 11

14- THE TRANSEUROPEAN NETWORKS AND INTEROPERABILTY

* The Treaty on European Union and the transeuropean networks

* The high speed network and interoperability

15- THE DRAFT DIRECTIVE ON INTEROPERABILY

* Notified bodies

* Technical specifications for interoperability (STI's)

* "Sector committee" to advise member states on approval of notified bodies

16- CONCLUSION

* The clash between a political vision and a proud tradition of high safety strandards

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Toshimasa Murakami

Administrative Regulation on Railway Undertakers

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

ADMINISTRATIVE REGULATION

RAILWAY UNDERTAKERS

Toshimasa MURAKAMI

Manager of Transport Safety Department
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ADMINISTRATIVE REGULATION ON RAILWAY UNDERTAKERS

By Toshimasa MURAKAMI
Manager of Transport Satety Dept.
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Administrative regulation may be defined as that the government and local public organizations participate or intervene in the activities of undertakings and people to achieve the political objectives specifically established. The current state of administrative regulation in Japan, as well as the administrative regulation and it relaxation regarding railway undertakings, are mentioned as follows:

1. Administrative Regulation in Japan

(1) Kinds and Objectives of Administrative Regulation

1) Economical Regulation

When there might be cases where appropriate supplies of goods and services and desirable price standards are not secured due to free market activities, the government directly regulates the qualification and number of participants in individual industries (participation regulation); the kind and quantity of plant and equipment investment (investment regulation); the volume and quantity of production (production regulation); and the price (price regulation), in order to contribute toward the sound development of industries and benefits of people.

In case of public services and utilities (railway, electric communications, electric power, and gas) that have a strong tendency to become naturally monopolistic on account of the size of economy, participation regulation is established, supply obligation and price regulation are also established, instead of approving a monopoly.

2) Regulation Means

Administrative regulation is established by means of laws, governmental and ministerial ordinances, by which prohibition, restriction, permission and authorization, and administrative guidance are enforced. For public services and utilities, individual undertaking laws, governmental and ministerial ordinances are established to govern detailed activities. (Refer to Table-1)

(2) Current State of Regulation

1) Kinds of Regulation (Permission, Authorization etc.)

Table-2 shows kinds of regulation in terms of permission, authorization etc., 17 in all. They are defined from the administrative point of view, but it is generally difficult to comprehend their differences. They are classified into three groups, as shown in Table-2.

Table-1 Regulation Objectives and Items for Public Services and Utilities

Regulation Objectives	Main Regulation Items
Prevention against bad effect of monopoly and oligopoly	Price regulation
Maintenance of appropriate price standards	Participation and price regulations
Prevention against ill influence of excessive	Participation, price, investment and service standards regulations
Consideration to income distribution	Price regulation
Safety security	Safety regulation

Table-2 Regulation Kinds (Terms) and Classification

Classification	Description	Kind
Group I	Entrusted to administrative agencies for judging standards to deal with applications	Permission, authorization, license, and approval
Group II	Dealt with by agencies based on certain dealing standards for applications	Recognition, confirmation, certification, recognition/ certification, test, inspection, examination, and registration
Group III	Not required of concrete dealing by agencies	Notification, submission, report, and issue

Group I is entrusted to administrative agencies for judgment to deal with applications; therefore, judging bases are least clear and their clarification is required.

As of Groups II and III, application judging bases are notified to the public, or simple notifications suffice; therefore, when compared with Group I, it seems that the procedures required are comparatively easy. Actually, however, acceptance of some notifications, for example, may be rejected. It is criticized unfavorably that these groups prevent active development of undertakings.

In the last Diet sessions, "Administrative Procedure Bill" was deliberated but not passed. If it is deliberated again in the current Diet sessions and passed, it is expected that at the request of an applicant, for instance, administrative judging contents will be made public in such a way as to further clarify the administrative dealing process.

2) Increase and Decrease of Regulation (Permission, Authorization etc.)

In Japan it had been difficult to grasp the actual state of regulation by permission, authorization etc. Therefore, The First Administrative Reform Deliberation Committee (July 1983-June 1986) submitted a report advising that the total number of items on permission, authorization etc should be systematically taken, and surveys have been conducted annually since 1985. (Refer to Table-3)

Table-3 Change in Numbers of Items on Permission, Authorization etc.

Ministry /Agency	Dec '85	Mar '87	Mar '88	Mar '89	Mar '90	Mar '91	Mar '92
Transport	2,017	1,976	1,977	1,962	1,988	1,966	1,966
Trade and Industry	1,870	1,866	1,883	1,900	1,908	1,916	1,915
Agriculture & Forestry	1,263	1,256	1,270	1,270	1,299	1,315	1,357
Others	4,904	5,071	5,148	5,309	5,386	5,520	5,704
Total	10,054	10,169	10,278	10,441	10,581	10,717	10,942

While regulation relaxation is required, Table-3 shows an increase of 888 items or up 8.8% during the period of 7 years, compared with the number of items taken at the first survey.

This is because that, along with change in social situations, items on permission, authorization etc. have been newly established, and prohibition and restriction relaxed; some conventional items have been abolished, but further new items necessarily provided, the latter exceeding the former in numbers.

2. Administrative Regulation on Railway Undertakings

In Japan, the ordinary railway and the Shinkansen (New Trunk Line) railway are separately governed by law. The Shinkansen railway was first opened to traffic in 1964. It is defined as a trunk line railway where trains run on most of its section at high speeds over 200km/h.

Attachment-1 shows the law system governing the railway undertaking (ordinary railway). It includes "Railway Undertaking Law" and "Railway Business Law," both of which apply not only to the ordinary railway but to the Shinkansen railway. For the Shinkansen railway, some regulations are exclusively established by ministerial ordinance.

(1) Laws

1) "Railway Undertaking Law"

This law provides for those, including the award of licenses to begin railway undertakings; submission of undertaking plans; approval of fares and charges; submission of railway facility construction plans; submission of train scheduling plans; and reporting on accidents when taken place.

The law was established in 1987, when the Japanese National Railways (JNR) was divided into privately operated railway companies (JR), in order to place both these new private railways and conventional private railways under the same law system. As JNR had been a member of the government organization the government had not intervened in its activities and it had been the system under which the JNR had been responsible for it activities by itself until divided. On the other hand, some of the conventional railways were small in size and operation, their technical standards were not so high as those of JNR, and their scope of responsibilities was limited. In other words, the activities of JNR and private railways were regulated differently under different laws. Attachment-II shows the transfer of regulation (permission, authorization etc) from JNR to JR.

When considered from the side of the conventional private railways, the regulation has been somewhat relaxed, but from the side of JR, the regulation has become stricter than in the period of JNR, in spite of much the same personnel.

2) "Railway Business Law"

This law was established in 1900. While "Railway Undertaking Law" governs railways generally as an undertaking, "Railway Business Law" governs railway technology, safety and service. That is, it regulates those including railway construction standards, rolling stock structures and train operation methods for safety and service, and the job system of railway personnel, and obligations which railway users should observe.

(2) Transport of Ministry Ordinances

1) Ministerial Ordinances Based on "Railway Undertaking Law"

a. "Railway Undertaking Law Enforcement Regulations"

Along with the enforcement of "Railway Undertaking Law," this regulations is established, stipulating for the methods of reporting on items of railway undertaking operation, including those items to mention when undertaking license application forms, undertaking plans, construction plans, and train operation plans are submitted.

b. "Railway Undertaking Accounting Regulations"

The method of railway undertaker accounting is provided in this regulations. Besides the accounting provided in the commercial code, the method of accounting exclusively used for the railway is stipulated by the Ministry of Transport.

This regulations provides for those items, including accounting principle, account classification, and the method of making financial statements.

c. "Railway Accident Report Regulations"

The method of classifying railway accidents taken place and damages incurred, and the standards of accidents that should be reported to the Ministry of Transport, as well as report forms, are all stipulated in this regulations.

For the details of this regulations, refer to another paper submitted.

d. "Railway Undertaking Report Regulations"

This regulations provides that after the end of each fiscal year the railway undertaker submits to the Minister of Transport and the Director of Local Traffic Bureau a business report and a railway undertaking performance report. The former report shows financial statements, and the latter report contains tables showing the transport performance and the state of facilities in possession.

e. "Railway Facility Inspection Regulations"

Railway facilities constructed, as well as those not involved in construction, shall be applied for inspection before they are put to use to obtain the approval by the Minister of Transport. This regulations provides for those, including the method of applying for such an inspection, and items regarding the organizations designated by the Minister of Transport when they perform such an inspection.

f. "Railway Undertaking Inspecting and Auditing Regulations"

This regulations provides for those items regarding inspection and audit by the Ministry of Transport on railway undertakers. The inspection and audit is classified into three: safety, business, and accounting. The safety inspection refers to the activities the railway undertaker performs for safety purposes. The business inspection involves in the actual state of services provided, which is inspected from the railway users' standpoint.

2) Ministerial Ordinances Based on "Railway Business Law"

a. "Railway Personnel Job System"

This is the ministerial ordinance enforced to show a guideline for job assignment of railway personnel.

This provides for job titles and descriptions of railway personnel, classified into traffic, mechanical, electrical, and rolling stock.

b. "Ministerial Ordinance Regarding Train Operation Safety"

In 1951 a train fire accident occurred in the then JNR killing as many as 106 people. Triggered by this accident, this ordinance was enforced, providing for safety models for the personnel engaged in train operations.

c. "Ministerial Ordinance regarding Driving Licenses for Motive Power Operators"

This ordinate is enforced stipulating for those, including the necessity of driving licenses to operate motive power (steam locomotives, electric cars, and internal-comburstion cars), and the qualification and test items regarding the obtaining of licenses and the revocation of licenses.

d. "Ordinary Railway Structure Regulations"

This regulations provides for the technical standards regarding the structure of facilities and rolling stock for the ordinary railway, with the Shinkansen railway not included. Basic items regarding the track, structures, electrical facilities, train operation safety equipment, and rolling stock are also stipulated in this regulations.

e. "Railway Operation Regulations"

This regulations provides for those, including the rules for railway workers to observe when they operate trains, the basic rules regarding the maintenance of facilities and rolling stock, and also the kinds of interlocking and signaling and their operating rules.

(3) Rules of East Japan Railway Company

1) Company Rules Notified to the Local Traffic Bureau Based on "Ordinary Railway Structure Regulations"

a. "Ordinary Railway Rolling Stock Structure Rules"

The structure of ordinary railway rolling stock and its parts are stipulated in detail in this rules.

b. "Track Arrangement Rules"

The structure, shape, arranging and load power of track are stipulated in this rules.

c. "Structure Arrangement Rules"

The regulating values, designing and installing standards of construction gauges, civil structures, bridges, stations and fire prevention equipment are stipulated in this rules.

d. "Electrical Facilities Installation Rules"

The designing and arranging standards of electric tracks and traction substations are stipulated in this rules.

e. "Signaling and Communications Equipment Installation Rules"

The designing and arranging standards of blocking, signaling, interlocking and automatic train stopping equipment are stipulated in this rules.

2) Company Rules Notified to the Local Traffic Bureau Based on "Train Operation Regulations"

a. "Train Operation Rules"

Those items provided in "Train Operation Regulations" and regarding the safety of train operation are stipulated in detail in this rules.

b. "Rolling Stock Maintenance Rules"

This rules stipulates for the maintenance of rolling stock by kind. The kinds, cycles, parts of inspection, as well as the recording of inspection results, are also stipulated in this rues.

c. "Track Inspection Rules"

This rules stipulates for the kinds, cycles and parts of regular inspection, as well as patrol inspection, of tracks and civil structures.

d. "Electrical Equipment Maintenance Rules"

This rules stipulates for the cycles and parts of inspection of all electrical equipment of those, including electrical train tracks, traction substations, blocking and signaling and interlocking equipment, and automatic train stoppers.

(4) The State of Application for Permission, Authorization etc

Applications for permission, authorization etc made by Japan East Railway Company to the Ministry of Transport and Local Traffic Bureau totaled 1,010 in fiscal year 1987, 1,360 in fiscal year 1988, and 1,310 in fiscal year 1989.

Table-4 shows the breakdown of applications for permission, authorization etc made in fiscal year 1989, with the first 6 items accounting for 71% of the total.

Tablo-4 The Breakdown of Applications for Permission, Authorization etc. Made by East Japan Railway in Fiscal Year Year1989

Item	Number	Percentage
Notification of change in railway facilities	319	24
Notification of forming or changing of train operation scheduling plans	260	20
Notification of fare and charge discount	120	9
Permission, authorization for change in railway facilities	98	8
Confirming application for rolling stock	77	6
Application for driving license	53	4
Others	383	29
Total	1,310	100

3. Regulation on Safety

The regulation regarding safety is provided in "Railway Business Law," as mentioned before. The rules governing the safety of train operation are mainly established in "Ministerial Ordinance regarding Driving Licenses for Motive Power Operators" and "Railway Train Operation Regulations," as mentioned before.

(1) "Ministerial Ordinance regarding Driving Licenses for Motive Power Operators"

This ordinance is enforced stipulating that it is necessary for railway workers to obtain driving licenses issued by the Director of Local Traffic Bureau in order to operate the motive power. Driving licences are classified into 5 kinds, as shown below:

- o Driving license for steam locomotives
- o Driving license for electric cars
- o Driving license for internal-combursion cars
- o Driving licence for Shinkansen trains
- o Driving licence for railless electric cars

To obtain a driving license, it is required for applicants to have the specified qualifications and pass the testes given. These qualifications are: age over 20, and no mental and physical disorder that affects the operation of motive power.

Test items are as follows:

- o Physical tost: eyesight, the field of vision, the power of hearing, blood pressure, mental disorder, defects in limbs etc.
- o Aptitude text: Kraepelin census, responsive speed etc
- o Writing test: train operation regulations, structure and function of motive power etc.
- o Ability test: train driving, braking, emergency measures etc.

These tests are all given by the Director of Local Traffic Bureau. Besides obtaining licenses by passing the tests given by the Director of Local Traffic Bureau, it is possible to take a driving license by completing the courses at the motive power operator training school designated by the Ministry of Transport and passing tests (contents are the same as those given by the Director of Local Traffic Bureau.) conducted by that training school.

East Japan Railway Company owns and operates such a training school. Therefore, any workers of the Company will receive training and take tests at this training school when they want to apply for a motive power driving license.

Motive power driving licenses will be canceled or revocated in cases where regulations regarding motive power operation are violated, where something is done against the conditions attached to the operating license, or where some mental or physical disorder that affects the motive power operation arises.

(2) "Train Operation Regulations"

This regulations has as many as 248 articles providing for those, including the training of and supervision over the railway workers, maintenance of railway facilities and rolling stock, and the dealing with train operation, in order to achieve the safe train operation of the ordinary railway, not the Shinkansen railway included. Each railway undertaker is obligated to establish its own rules based on this regulations and to submit it to the Director of Local Traffic Bureau in advance. In this way, all the railway undertakers are required to perform their activities and ensure the safe train operation, as directed by the ministerial ordinance.

As part of training, the aptitude test is given to all the railway workers engaged in the work regarding train operation. These workers include train or rolling stock operators, those engaged in the arranging of train operation, handling of signals, points and switches, as well as the maintenance of safety equipment of tracks and overhead lines.

As for the maintenance of railway facilities, and rolling stock, the inspection required when newly installed or improved or repaired, and the kinds, cycles etc of regular inspection, are all stipulated.

items on train operation, including conditions of train equipment and train operation, the method of rolling stock switching, train speeds, the kinds and rules of blocking, signals, signs and marks, are also stipulated.

4. Regulation Relaxation

There is a tendency becoming stronger among railway undertakers toward reviewing the regulation imposed on them for revising some of the laws and regulations now in force, because many regulating items on railway undertakings may be considered unsuitable to actual situations.

Take problem cases for example under the current regulation. There are items obviously provided to enhance the benefit and convenience of users, but some of them require much time and trouble to get through the procedures established, and some others overlapped and necessitated to take from more than one government organization. (Refer to the Attachment-3)

Under these circumstances, the Ministry of Transport began in 1992 reviewing laws and regulations regarding technical standards for revision in such a way as to realize railways that may meet the social demands. After hearing the demands from undertakers, the Ministry organized the study groups (train operation, rolling stock, civil, and mechanical). Each group held meetings, making investigations and studies. And in March of 1993, the first revision of laws and regulations concerned was made. Fro example, In "Ordinary Railway Structure Regulations," the effective length of station platform had been stipulated to be the total of the maximum length of a train arriving and leaving plus 5 meters. This was revised to read the total of the maximum length of a train from which passengers get on and off, with locomotive or power car not included, plus 5 meters. Also in this regulations, the overhead line had been stipulated to be over 5 meeters but less than 5.4 meters above the rail surface. This was so revised that the bottom limit is now 4.8 meters where it is not so easy for people to enter or leave because of overhead bridge. The revision thus made then was extremely slight, not quite satisfactory to the railway undertakers. However, these groups continue making investigations and studies for further effective revision.

5. Conclusion

The railway undertaking is a public undertaking, and it is in a position where its activities are regulated in various ways. Nevertheless, a move to relax the regulation has been becoming stronger since last year. Close attention will be paid to the further movement. Regardless of the regulation enforced, efforts will be exorted to make a railway undertaking that will serve not to hurt the benefit and convenience of users.

Attachment 1

Law System Regarding the Railway Undertaking (Ordinary Railway)

Laws	Ministerial Ordinances	East Japan Railway Rules
Railway Undertaking Law	Railway Undertaking Laws Enforcement Regulations	
	Railway Undertaking Accounting Regulations	
	Railway Accident Report Regulations	
	Railway Undertaking Report Regulations	
	Railway Structure Inspection Regulations	
	Railway Undertaking Inspection and Audit Regulations	
Railway Business Law	Railway Personnel Job System	
	Ordinary Railway Structure Regulations	Ordinary Railway Rolling Stock Structure Rules
		Track Arrangement Rules
		Structure Arrangement Rules
		Electrical Structure Rules
		Signal & Communications Equipment Installation Rules
	Ministerial ordinance regarding train operation safety security	
	Ministerial ordinance regarding motive power operator driving license	
	Train Operation Rules	Train Operation Rules
		Rolling Stock Maintenance Rules
		Track Inspection Rules
		Electrical Equipment Maintenance Rules

Attachment-2

Transfer of Regulation (Permission, Authorization etc.) from JNR (O) to JR (X) (o→x)

Item	Group I approval, license etc	Group II test, inspection etc	Group III notification, report etc	OR or NR
Participation into undertaking	x ←	←	←	o
Application form for participation into undertaking			x ←	o
Change in undertaking basic plan	x ←	←	o	
Extension of construction period			x ←	o
Change in minor undertaking basic plan			x ←	o
Change in minor construction plan			x ←	o
Construction ompletion inspection		x ←	o or	o
Railway facility inspection		x ←	←	o
Minor change in rolling stock			x ←	o
Fares and charges	x			
Fare and charge discount			x ←	o
Train operation scheduling and change in train operation schedule-ing			x ← o	
Accident report			x ← o	
Entrusting to/ from of train operation	x ←	←	←	o

supervision	
Undertaking merging	x ←——————————— NS
Undertaking inheritance	x ←——————————— NS
Juridical person (corporation) dissolution	x ←——————————— NS
On-the-spot inspection	x ←——— NS
Change in description on licence	x ←——— NS

OR or NR = Own Responsibility or No Regulation
NS = No system

1. Items arrow marked denote no change made when transferred to JR.

2. Items marked in the same group denote that regulation contents were changed within that group.

Attachment-3

Current Regulation on Railway Undertakings: Problem Cases

Regulation Item	Actual Case (Current Regulation)
Regulation against cases which obviously turn convenient and beneficial to users	o Notification should be made of discount items that obviously become related to the benefit and convenience of users. o Notification should be made of all trains specially scheduled for groups, events etc. o Authorization required for establishment of fares and charges, even basic ones are applicable, when a new station is open.
Overlapped regulation	o Items that require overlapped permission or authorization from more than one government organization: - MOT and MIT, for traction substation facilities, generators for station emergency power source - MOT and MPT, for train radio equipment o Procedures of explanation to both MOT and Director(s) of LTB
Technical standards stricter than required	o Items whose safety is confirmed from the past experience: - overhead line height, deviation track center, materials, distance from other structures. - Rails are used when the current for moving electric cars returns to the traction substation: jointing resistance values of these rails. - the length of easement curve added to the curve section of rail.
Regulation: many items specially approved	o Rolling stock structure: - passenger car seating is chair type, and the seating capacity is stipulated to be a third of passenger loading capacity; however, there are many cases specially approved of sleeping cars; Ozashiki-type cars (floor matted like Japanese room), and commuter train cars

	equipped with foldable seats and used as standing cars during rush hours.
Uniform regulation: cases not applicable primarily	o Passenger seating standards applicable to rolling stock: - the above standards applicable to dining cars, lobby cars not primarily designed for the movement of passenger; therefore, difficult to design such cars' seating to meet the demands of users.
	o Emergency braking distance of of train: - stipulated that the train must stop within 600 meters within 600 meters when braking is applied for emergency; however, this braking distance applies event to the elevated section in whole with no level crossing provided.
Regulation: model methods not correct essentially	o Items regulated from the view of materials, not capacity: - passenger car window pane, which should be safety one.
Regulation: cases where preconditions are changed when established	o Introduction of new technology: - indication method of cabin signal, which shows limit speeds in figures based on speed limit signal from the ground, not by using the ground signal.

MOT=Ministry of Transport
MIT=Ministry of International Trade and Industry
MPT=Ministry of Post and Telecommunications
LTB=Local Traffic Bureau

Administrative Regulation on Railway Undertakers

By Toshimasa MURAKAMI
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Copies of OHP Sheet

Difinition of Administrative Regulation

- The government and local public organizations participate or intervene in the activities of undertakings and people to achieve the political objectives specially established.

Kinds of Administrative Regulation

- **Economical Regulation** : Regulation to be enforced when there might be cases where appropriate supplies of goods and services and desirable price standards are not secured due to free market activities
  - **Participation Regulation** : Regulation on qualification and number of participants in individual industries
  - **Investment Regulation** : Regulation on kinds and amounts of investment
  - **Price Regulation** : Regulation on prices
  - **Service Standerds Regulation** : Regulation on service standards for customers

- **Social Regulation** : Regulation to be enfoced from the viewpoint of the maintenance of social order, including the security of safety and health of consumers and laborers, preservation of environment, and prevention of of disasters

Regulation Kinds (Terms) and Classification

Classification	Description	Kind
Group I	Entrusted to administrative agencies for judging standards to deal with applications	Permission, authorization, licence, and approval
Group II	Dealt with by agencies base on certain dealing standards for applications	Recognition, confirmation, certification, recognition/certification, test, inspection, examination, and registration
Group III	Not required of concrete dealing by agencies	Notification, submission, report, and issue

Change in Numbers of Items on Permission, Authorization etc.

Ministry/ Agency	Dec' 85	Mar' 87	Mar' 88	Mar' 89	Mar' 90	Mar' 91	Mar' 92
Transport	2,017	1,976	1,977	1,962	1,988	1,966	1,966
Trade and Industry	1,870	1,866	1,883	1,900	1,908	1,916	1,915
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	Railway Accident Report Regulations	
	Railway Structure Inspection Regulations	
	Railway Undertaking Inspection and Audit Regulations	
Railway Bussiness Law	Railway Personal Job Syatem	
	Ordinary Railway Structure Regulations	Ordinary Railway Rolling Stock Structure Rules
	Ministerial Ordinance Regarding Train Operation Safety Security	Track Arrangement Rules
	Ministerial Ordinance Regarding Driving Licenses for Motive Power Operators	Structure Arrangement Rules
		Electrical Structure Rules
		Signal&Communications Equipment Installation Rules
	Train Operation Regulations	Train Operation Rules
		Rolling Stock Maintenance Rules
		Track Inspection Rules
		Electrical Equipment Maintenance Rules

Transfer of Regulation (Permission, Authorization etc.) from JNR (○) to JR (×) (○ → ×)

Item	Group I approval, license etc	Group II test, inspection etc	Group III notification, report etc	Own Responsibility or No Regulation
Participation into undertaking	× ←	←	←	○
Application form for participation into undertaking			× ←	○
Chage in undertaking basic plan	× ←	←	←	○
Change in minor undertaking basic plan			× ←	○
Extension of construction period			× ←	○
Change in minor construction plan			× ←	○
Construction completion inspection		× ←	○ or	○
Railway facility inspection		× ←	←	○
Minor change in rolling stock		× ←	←	○
Fare and charges	×			
Fare and charges discout			× ←	○

Item	Group I approval, license etc	Group II test, inspection etc	Group III notification, report etc	Own Responsibility or No Regulation
Train operation schduling and change in train operation schduling			× ← ○	
Accident report			× ←	○
Entrusting to/from of train operation supervision	× ←	←	←	○
Undertaking merging	× ←	←	←	No System
Undertaking inheritance	× ←	←	←	No System
On-the-spot inspection			× ←	No System
Change in description on license			× ←	No System

1. Items arrow marked denote no change made when transferred to JR.
2. Items marked in the same group denote that regulation contents were changed within that group.

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	Railway Structure Inspection Regulations	
	Railway Undertaking Inspection and Audit Regulations	
Railway Bussiness Law	Railway Personal Job Syatem	
	Ordinary Railway Structure Regulations	Ordinary Railway Rolling Stock Structure Rules
		Track Arrangement Rules
		Structure Arrangement Rules
		Electrical Structure Rules
		Signal&Communications Equipment Installation Rules
	Ministerial Ordinance Regarding Train Operation Safety Security	
	Ministerial Ordinance Regarding Driving Licenses for Motive Power Operators	
	Train Operation Regulations	Train Operation Rules
		Rolling Stock Maintenance Rules
		Track Inspection Rules
		Electrical Equipment Maintenance Rules

Ministerial Ordinances Based on "Railway Undertaking Law"

Law	Ministerial Ordinances
Railway Undertaking Law	Railway Undertaking Laws Enforcement Regulations
	Railway Undertaking Accounting Regulations
	Railway Accident Report Regulations
	Railway Structure Inspection Regulations
	Railway Undertaking Inspection and Audit Regulations

Ministerial Ordinances Based on "Railway Business Law"

Law	Ministerial Ordinances
Railway Business Law	Railway Personal Job System
	Ordinary Railway Structure Regulations
	Ministerial Ordinance Regarding Train Operation Safety Security
	Ministerial Ordinance Regarding Driving Licenses for Motive Power Operators
	Train Operation Regulations

Company Rules Notified to the Local Traffic Bureau Based on "Ordinary Railway Structure Regulations"

Ministerial Ordinances	East Japan Railway Rules
Ordinary Railway Structure Regulations	Ordinary Railway Rolling Stock Structure Rules
	Track Arrangement Rules
	Structure Arrangement Rules
	Electrical Structure Rules
	Signal & Communications Equipment Installation Rules

Company Rules Notified to the Local Traffic Bureau Based on "Train Operation Regulations"

Ministerial Ordinances	East Japan Railway Rules
Train Operation Regulations	Train Operation Rules
	Rolling Stock Maintenance Rules
	Track Inspection Rules
	Electrical Equipment Maintenance Rules

The breakdown of Applications for Permission, Authorization etc. Made by East Japan Railway in Fiscal Year 1989.

Item	Number	Percentage
Notification of change in railway facilities	319	24
Notification of forming or changing of train operation scheduling plans	260	20
Notification of fare and charge discount	120	9
Permission, Authorization for change in railway facilities	98	8
Confirming application for rolling stock	77	6
Application for driving license	53	4
Others	383	29
Total	1, 310	100

Ministerial Ordinances Governing the Safety of Train Operation

Law	Ministerial Ordinances
Railway Business Law	Ministerial Ordinance Regarding Driving Licenses for Motive Power Operators
	Train Operation Regulations

Kinds of Driving License

- Driving License for Steam Locomotives
- Driving License for Electric Cars
- Driving License for Internal-combursion Cars
- Driving License for Shinkansen Trains
- Driving License for Railless Electric Cars

Items of Driving License Test

- Physical Test : eyesight, the field of vision, the power of hearing, blood pressure, mental disorder, defects in limbs etc.
- Aptitude Test : Kraepelin census, responsive speed etc.
- Writing Test : train operation regulations, structure and function of motive power etc.
- Ability Test : train driving, braking, emergency measures etc.

Contents of "Railway Operation Regulations"

- Chapter 1 General (Articles 1–6)

  Objective of ministerial ordinance, establishment of rules by railway undertakers and their notification

- Chapter 2 Railway Workers (Articles 7–14)

  Training and supervision of railway workers, aptitude tests for railway wokers engaged in work regarding train operation

- Chapter 3 Maintenance of Railway Facilities and Rolling Stock (Articles 15–51)

  Inspection of railway facilities when they are newly built, installed, improved or repaired, including tracks, electric power equipment, signals, level crossing equipment and rolling stock

- Chapter 4 Train Operation (Articles 52–93)

  Train conditions, operation conditions, rolling stock switching, and train speeds

- Chapter 5 Blocking etc. (Articles 94–163)

  Blocking nacessity to operate trains, kinds of blocking system, and conditions of each blocking system

- Chapter 6 Railway Signaling (Articles 164–248)

  Kinds of signaling, methods of indication, and confirmation distance of signals

Current Regulation on Railway Undertakings: Problem Cases

Regulation Item	Actual Case (Current Regulation)
Regulation against cases which obviously turn convenient beneficial to users	○Notification should be made of discount items that obviously become related to the benefit and convenience of users.
Overlapped regulation	○Items that require overlapped permission or authorization from more than one goverment organization: –Ministry of Transport and Ministry of international Trade and Industry, for traction substation facilities
Technical standards stricter than required	○Items whose safety is confirmed from the past experience: –overhead line height, deviation track center
Regulation: many items specially approved	○Rolling stock structure: –passenger car seating is chair type, and the seating capacity is stipulated to be a third of passenger loading capacity; however, there are many cases specially approved of sleeping cars etc.

Regulation Item	Actual Case (Current Regulation)
Uniform regulation: cases not applicable primarily	○Passenger seating standards applicable to rolling stock: –the above standards applicable to dining cars, lobby cars not primarily designed for the movement of passenger.
Regulation: model methods not correct essentially	○Items regulated from the view of materials, not capacity: –passenger car window pane, which should be safety one.
Regulation: cases where preconditions are changed when established	○Introduction of new technology: –indication method of cabin signal, which shows limit speeds in figures based on speed limit signal from the ground

International Rail Safety Conference

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9307

Ray Ryan

Safety Management System in New Zealand Rail Limited

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

SAFETY MANAGEMENT SYSTEM IN NEW ZEALAND RAIL LIMITED

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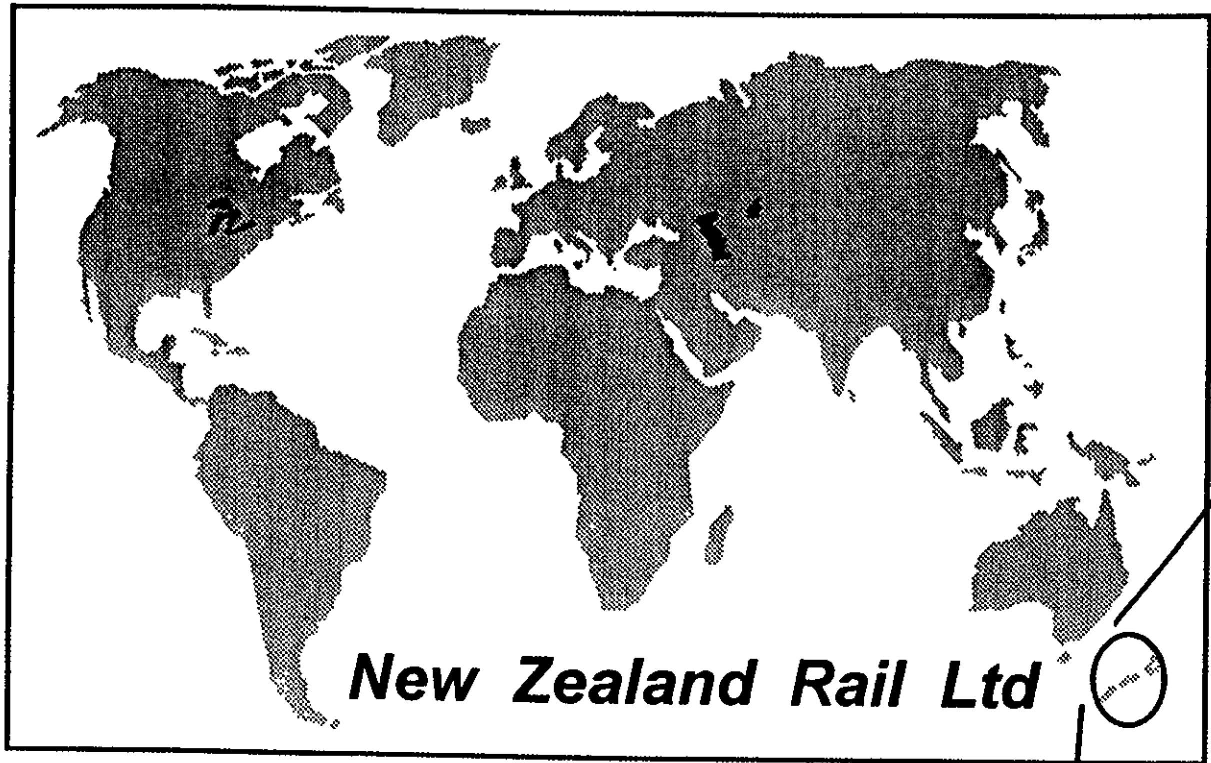
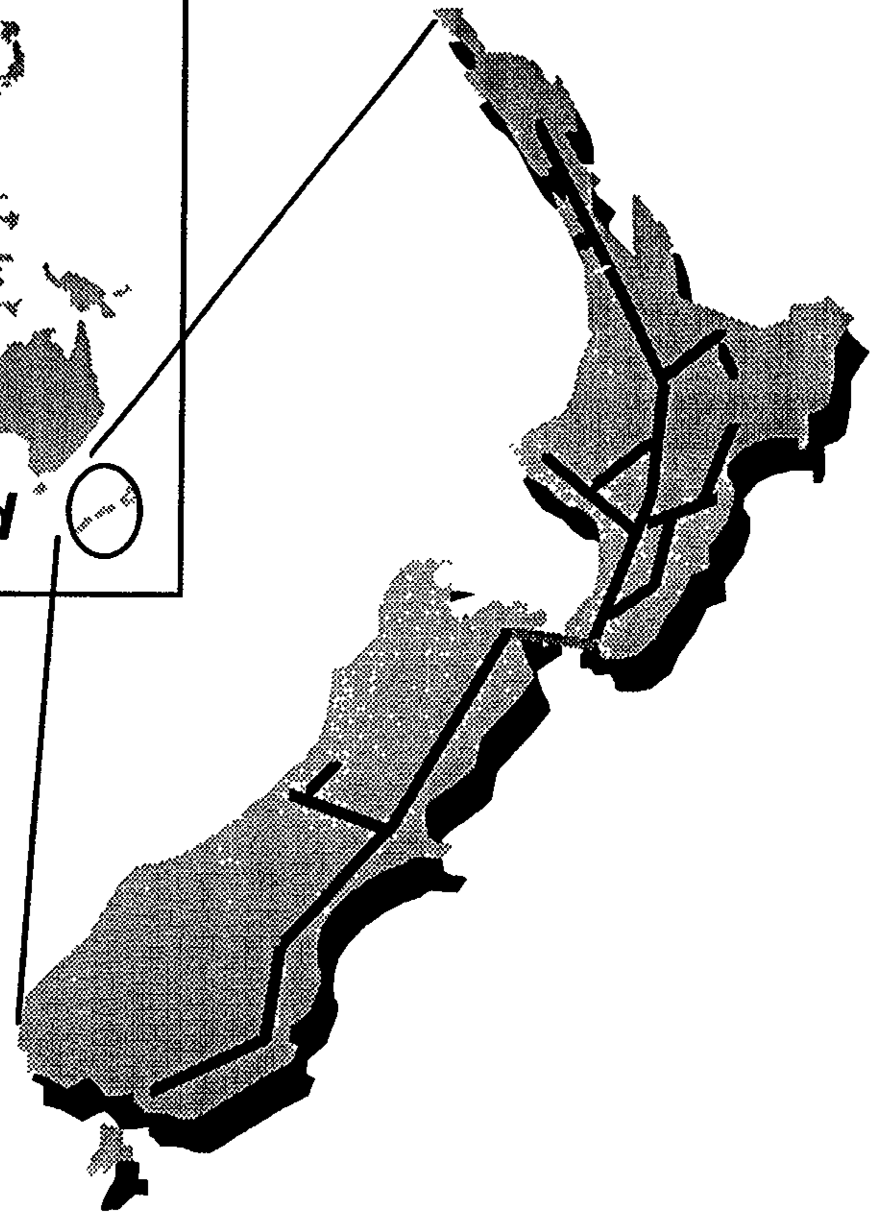
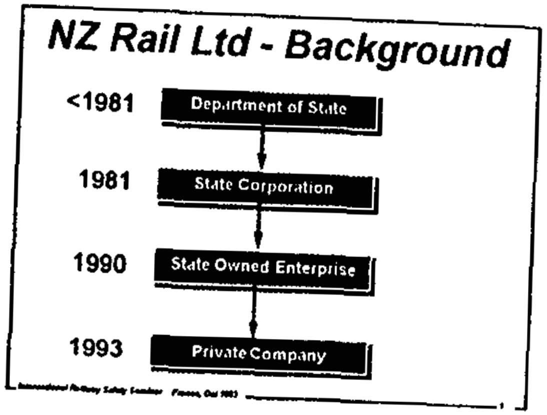


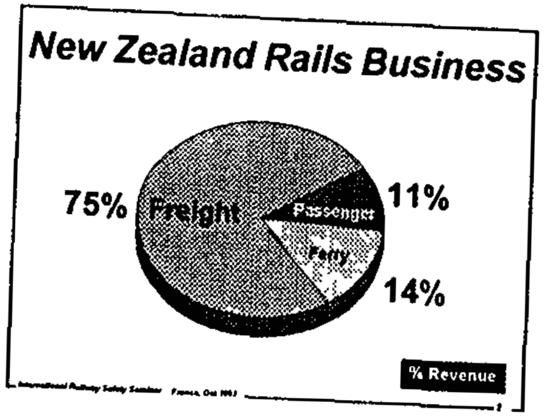


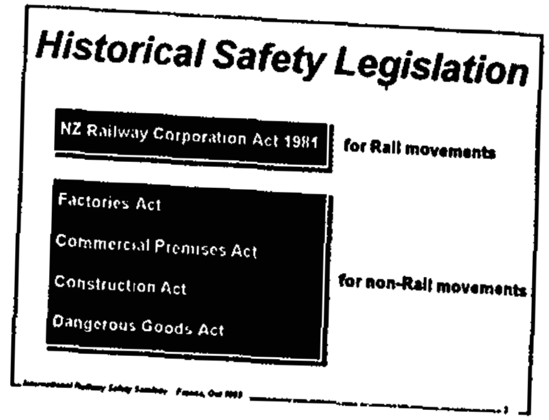
SAFETY SYSTEM for Control of Rail Service Vehicles

Safety System for Control of Rail Service Vehicles - *A presentation by Ray Ryan, Executive Manger Quality & Safety, NZ Rail Ltd*

Presentation Slides & Notes page.







YOUR NOTES

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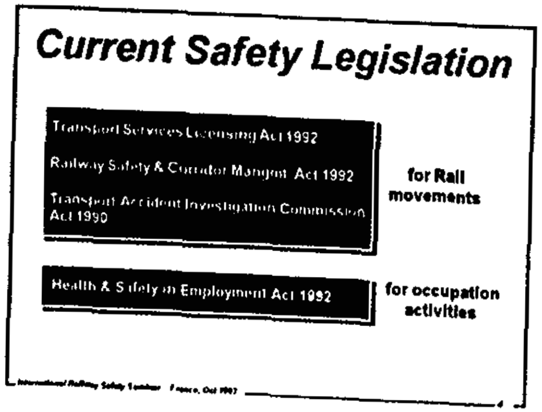

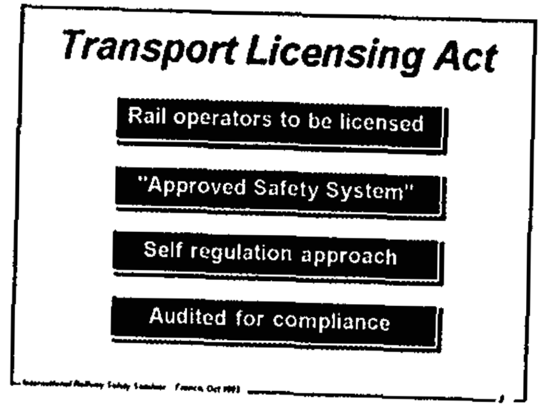

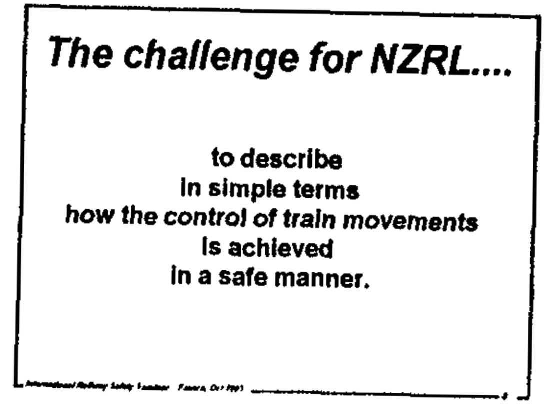

YOUR NOTES

Safety System for Control of Rail Service Vehicles - *A presentation by Ray Ryan, Executive Manger Quality & Safety, NZ Rail Ltd*

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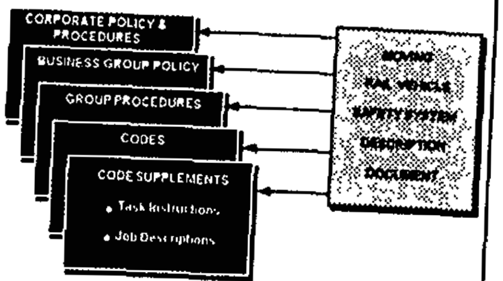
Describing the system...



Safety System Description Document

Part I — Introduction / Business Environment

Part II — Safety System Components

Part III — Moving Rail Vehicle Process Control

Safety System Description Document - Part II

- System control
- Safety philosophy & policy
- System parameters
- Human Resource Management
- Moving Rail Vehicle process (Summary)
- Audit regime

YOUR NOTES

Moving Rail Vehicle Control covers three Operations...

Mainline Operation

Shunting Operation

Special Operations

Main Line Train Operation

Definition:

A main line train consists of:-

- a locomotive(s) and wagons with train end monitor
- *or* a locomotive(s) and passenger carriages
- *or* combination of the above
- *or* electric multiple unit (EMU)
- *or* diesel railcar or multiple unit (DMU)

A mainline train operation:-

starts with a train moving from the point of departure in a marshalling yard or freight terminal (freight trains) or an originating passenger terminal,

to the main line,

along the main line route,

ends after entering and being brought to rest at the end point in the journey within a marshalling yard/freight terminal or passenger terminal

Process Description:

This operation is described in six elements. Each element defines a series of "holons". Each holon has references to documentation to ensure competence

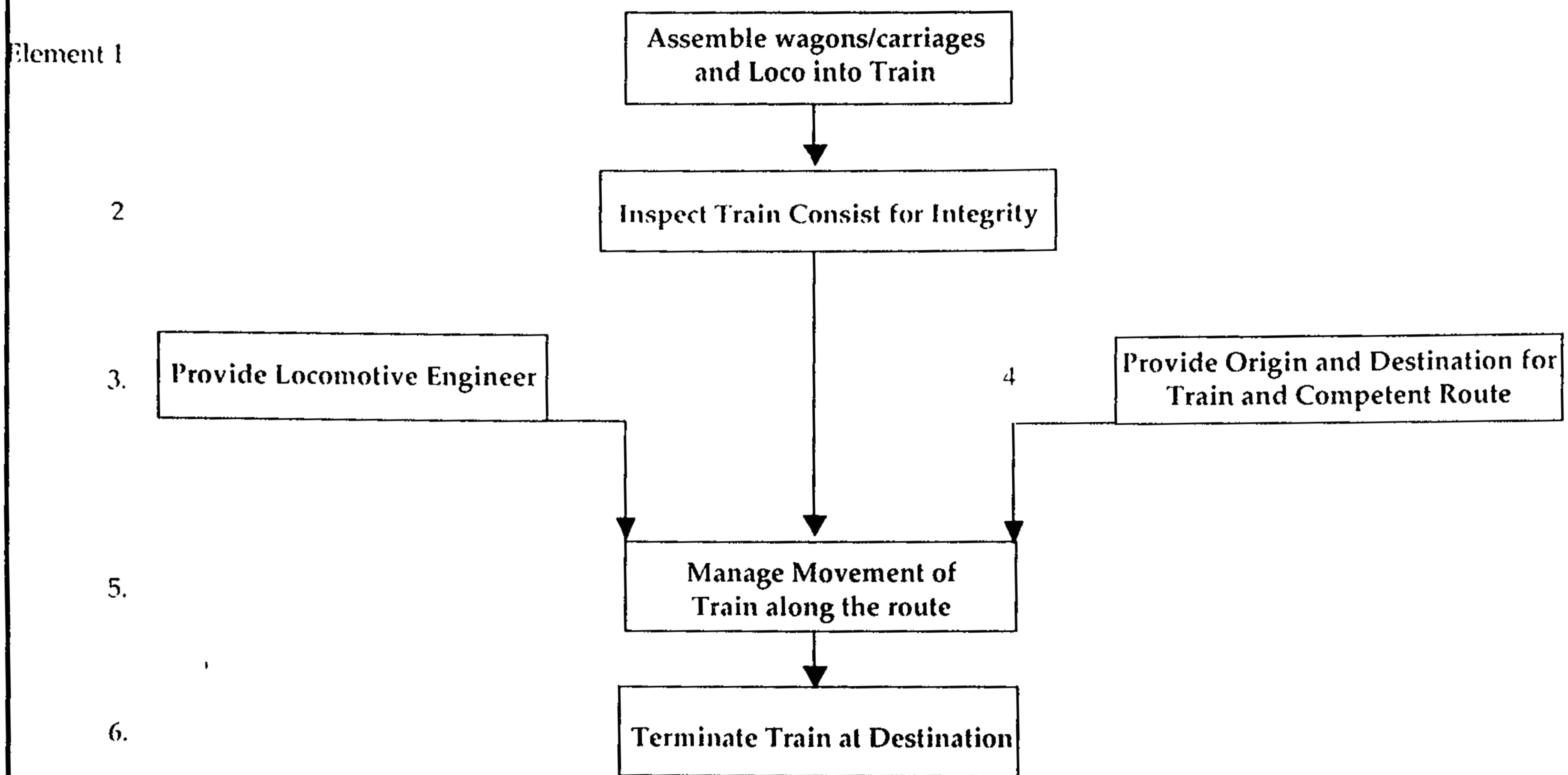
Not Described:

shunting movements along the route (see marshalling and distribution process description)

Main Line Train Operation

Description of

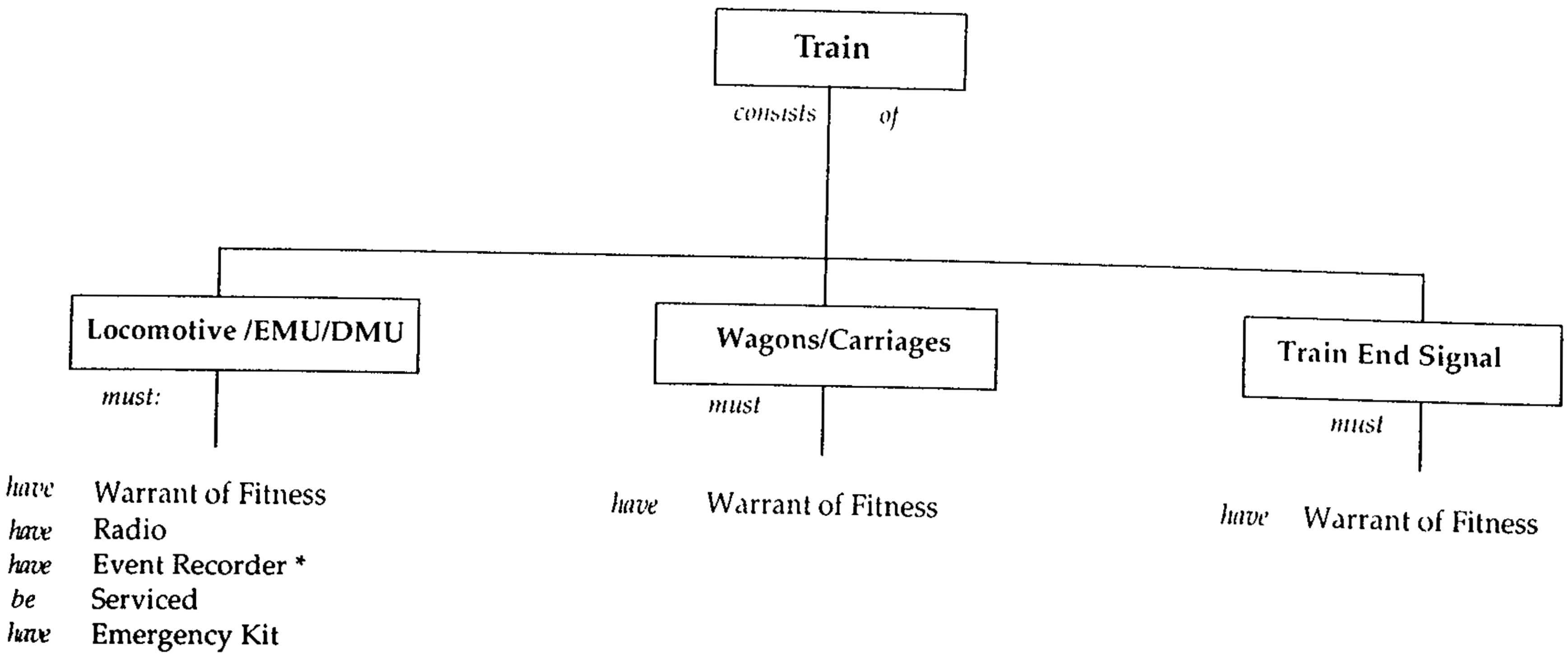
Process Elements



Main Line Train Operation

Description of Element 1

Assemble Wagons and Loco into Train Consist



* EMU's and DMU's are not equipped with event recorders

Main Line Train Operation

Description of Element 2

Inspect Consist for Integrity

Train Inspection

process requires

Human Inputs

of

- Competent Persons
  - Train Examiners
  - Loco Engineers

Physical Requirements

complying with

- Marshal Order Criteria
- Completeness of linking units (couplings and running gear fitness)
- Loading Criteria of
  - right to run on proposed route
  - special loads identified and permits issued
  - load secured in accordance with code

Tests

to be completed and competence confirmed, of

- Train end protection device
- Warning device operation
- Consist Brakes
- Locomotive Radio

Main Line Train Operation

Description of Element 3

Provide Locomotive Engineer

Locomotive Engineer

must have **Basic Requirements**

of being a
- competent person

with
- current certification
- route knowledge up-to-date

must have **Shift requirements**

which are to be:
- fit for shift
- rostered in accordance with standards
- in good health (day to day)
- briefed for shift
- competent for duties of shift

must have **Information Requirements**

which consist of
- documentation
- train advices
- o'gauge load permits
- hazardous goods schedule
- crossing total
- event recorder certificate
- train information sheet

must perform **Tasks**

which are to:

Test
- brakes
- warning device
- radio
- TEM

Perform
- train inspection
- advise on non routine occurrences & loco faults

Ensure
- loco emergency kit is available

Main Line Train Operation

Description of Element 4

Provide Origin and Destination Plus Competent Route

the **Movement Parameters**

are controls on-

- Speed
  - train
  - route
  - curve boards
  - permanent restriction
  - temporary restriction
  - blocks of line
- Signalling
  - type
  - aspects
  - signs
  - procedures — routine
  - procedures — non routine

The Locomotive Engineer must have knowledge of route and physical aspects of:

- grades
- curves
- tunnels
- level crossings
- hazards
- signal location
- station location/yards

the **Fixed Asset Parameters**

are controls on

Basic Features

- track
- structures
- signals
- traction O'head
- communications

Special Features

- level Crossings
- stations
- public access
- private access
- security of route
- external
  significant facilities
  (eg LPG Installations)
- variations to route standards

3rd party

Work Permits

Main Line Train Operation

Manage Movement of Train

Train Movement

Train Running Operation

must

- provide authority to proceed
- plan movement
- manage movement for
  - routine adjustments
  - emergency management
  - work of train adjustments
- give train information (ex Transit Control) to L/E .
- Interact with signal boxes along route and at terminals

have

- change-over procedures for staff between shifts

Train Control Operators

must be

- a competent person
- fit for shift

and have

- current certification

must perform in a duty environment which

- is rostered within standards
- is a suitable work environment
- has adequate tools of
  - train advices
  - rules/regualtions
  - W.T.T
  - Operating Code

must

- be briefed at commencement of shift
- brief takeover staff at end of shift
- qualified for rostered duties
- be in communcation with
  - train crews
  - ground train staff movement
  - signalman
  - transit control

  for duration of shift

Main Line Train Operation

Description of Element 6

Train Stops at Destination

Train Stops

Train Must | *Crew Perform*

Environment

Train crew notes

- Change in signalling regime, from Main Line System under train control to terminal system under local control

Operational Tasks

which are to

- Stop train

and,

- with yard staff,
  - Berth train
  - Cut off Loco from train
  - Park Loco at Depot

Administration Tasks

which are to.

- Book off duty
- Record loco defects in log
- Deposit train documentation

Train Marshalling and Wagon Distribution Process

Definitions :

The train marshalling process is the assembly or disassembly of a Main Line Train .
The distribution process is the movement of discrete wagons/carriages or groups of discrete wagons/carriages to or from the point of arrival or departure of a Main Line Train.

Process Description :

the operations are described in 8 elements commencing with

- start up requirements for shunt crews and equipment

moving through

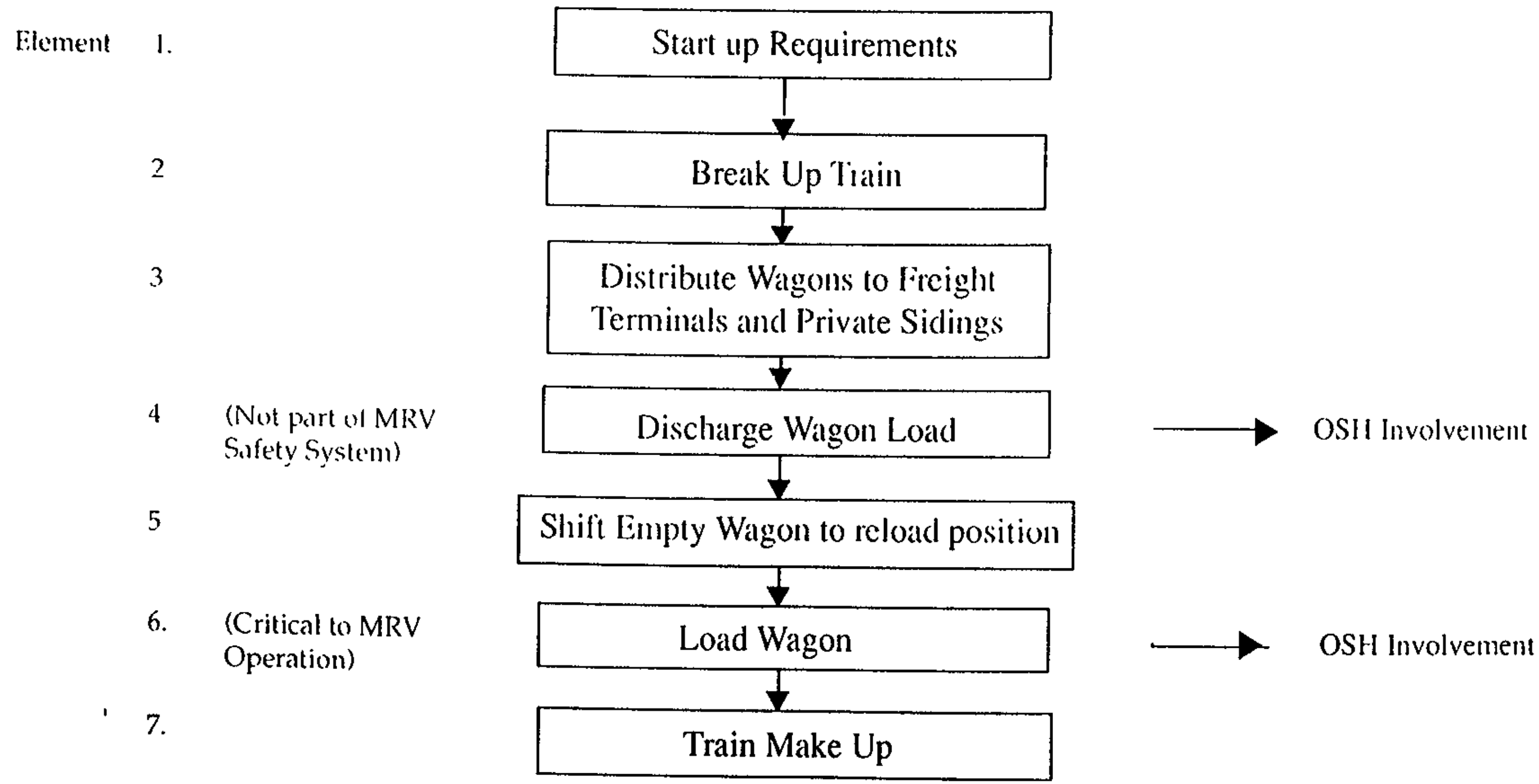
- disassembly of the main line train
- movement of wagons/carriages to discharge/terminal points
- repositioning movements of wagon (if necessary) for reloading or park position
- movement of loaded wagons to train assembly point

and ending in

- a main line train assembled in preparation for attaching the locomotive and for train integrity testing prior to departure

Train Marshalling and Wagon Distribution Process

Description of Process Elements



Special Operations Process

Definition:

A Special Operation is:-

- Work train

or • Heavy on - rail mobile maintenance machinery operating singly or in a group

or • Light rail inspection vehicle or motor trolley

or • Maintenance activities affecting route integrity

Authorised to operate within:-

- Clearly defined boundaries and time constraints

Under:-

- Competent site control

Special Operations Process

Description of Elements

Element	Description
1 #	Authorisation for RSV to Move to Work Site by Train Control
2 * #	RSV moves to Worksite
3 *	Authorisation by Train Control to establish Work Site
1	Work within site under Site Control
5 *	Release Work Site to Train Control by Site Control
6 * #	RSV Moves From Work Site
7#	Release Work Site to Normal Operations by Train Control

* These elements do not apply to LIVs or trolley operations

\# These elements do not apply to maintenance activities affecting route integrity

Description of

Passenger Management Activities

Train Movement

As per wagon
(Appendix 3)

Train Manager

must be

- Competent
- Fit for Shift

and hold a

- Current Certification

Tasks

The TM must

- Perform safety briefing
- Ensure behaviour control on journey
- Verify passenger travel authorisation
- Ensure passenger welfare
- Transfer contol of L/E after passenger set downs or pick ups
- Be responsibility for emergency Management en route
  - evacuation of carriage
  - protection of trains
  - liaison with emergency services
- Assist L/E/ in emergency train movements

Administration

Duties

- Verify passenger lists
- Provide any special

Summary

- Safety System documentation already exists
- System description provides a map

LEADS TO ↓

- Rationalisation / simplification of documentation
- Enhanced System effectiveness

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9308 Part 1

David Rayner

Development of Risk Management in British Rail and the Safety Case Practice

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

SAFETY CASE PRACTICE

David RAYNER

Board Member
British Railways Board

International Railway Safety Seminar
Angers, France, October 1993

Development of Risk Management in British Rail and the Safety Case Process

Paper by D E Rayner, Board Member Operational Standards & Safety, BR

Historical Overview

BR is the current inheritor of our 150 years tradition of railway operation. The safety of passengers has always been a high priority but early fragmentation of the industry (over 170 railway companies) meant that common standards were difficult to obtain.

Originally there was almost a "free for all" but eventually the regulating body was given powers to control activities. It must be noted that there was great innovation in some places - others were sometimes slow to respond.

Concentration was on safety of passengers and in real terms rail transport was quite safe, but each railway company was inward looking, not seeking out the best safety management systems of the world - they did not always challenge themselves about how much safer they could be.

The emphasis was on making the rules so robust that if followed, accidents couldn't happen. No great consideration was given to the needs of the people following the rules and the conditions under which they worked. There was a culture of "the trains must get through".

Major advances in technical safety of railway were often brought about following accidents, or series of accidents and it is useful to focus on four which led to some major technical changes.

CLAYTON TUNNEL 1861 which led to absolute block working and telegraphs (but not until 1874).

ARMAGH 1889 which led to continuous automatic vacuum brakes

QUINTINSHILL 1915 which led to elimination of gas lighting and replacement by electricity and

HARROW & WEALDSTONE which led to national installation of Automatic Warning System

(Note - AWS was introduced on GWR in 1906 and modified in 1910 to apply brakes as well as give audible warning)

Throughout the period improvements were made to system safety. In every case, this was following accidents, adding new safety devices to overcome human error but not addressing human error itself.

It is interesting to note that the concept of risk and risk management is absent from this process - change followed real failure, not the risk of failure.

Accident Rates on BR

Our records for personal accidents don't go back quite as far as those years - we do have graphs showing passenger and staff fatalities from 1920 (see figures 1 and 2).

Note passenger fatalities are at about 90 - 100 per year from 1920 - 1950 with the Harrow & Wealdstone accident occurring in 1952. The railway needed major rebuilding after the war - there was a big programme of modernisation from 1952 (AWS) and a major programme from 1955 - 1965, finished 1970

- new T&RS (all steel)
- new signalling
- new track (continuous welding)

The passenger fatality rate was reduced to about 35 per year by 1970 and then stayed broadly constant.

Staff fatalities were not specifically addressed in earlier years because they happen in penny packets, not in large numbers at once.

1920's to 1950 - about 220 - 230/year on average

Modernisation made trackside safer

- continuously welded rail
- marshalling yards improved

Number of deaths declined rapidly

Also changed techniques
- no loose shunting

The number of fatalities steadily declined to about 20 through 1980's. Also the number of staff decreased as the railway declined in size. These graphs are not normalised but even normalised figures show an over 4 fold reduction in staff fatality rate.

Growing Appreciation of Risk

The last major investment period was 1952 - 1970. By the early/mid 1980's the earlier parts of that new equipment were themselves coming up for renewal.

There were 2 other major influences:

1. a recognition that BR had to be put on a business footing

    - emphasis on markets and customers
    - development of InterCity, NSE etc as "Businesses", called Sectorisation

2. financial stringency

Thus during this period BR was in the throes of the major change to Sectorisation, which introduced new interfaces and new decision makers. There were cost/time pressures from the new sub-sector managers who had no direct responsibilities for safety but controlled the purse strings. Because of the pressure on costs, BR was reducing the size its workforce and key staff were disappearing; this led to a loss of experienced and senior staff - a lot of expertise disappeared.

At the same time, there was a great deal of technical innovation, all of which placed great pressure on experienced technical staff

- resignalling schemes involving solid-state interlocking (rather than mechanical or electromechanical)
- new, lightweight trains
- higher speeds of trains
- east coast electrification

To compound this, the old culture on BR was still to the fore

- the "rule book" culture
- poorly defined standards
- supervision essentially by better operators, not lower level managers
- traditionally trained workforce - "sitting with nelly" and formalised training and apprenticeship
- ambiguity of responsibility
- traditionally trained management which was essentially risk averse - if it suspected an unsafe situation, the rules were tightened

There was little if any process of monitoring and audit to determine whether the personal safety rules were being followed (or could be followed) and no feedback. Junior management turned a blind eye to rule infringement in order to get the job completed in time. The idea of delaying work to ensure it was done safety was never prohibited, but equally never supported.

The net result of this culture was to increase risk within the organisation.

<u>Change Over Point</u>

Even whilst BR was identifying these areas of weakness, the fire occurred at Kings Cross station. Whilst this was strictly an issue for LUL, as events unfolded it became clear that many of the lessons learned would apply equally to BR. Indeed, the BR Board announced publicly that it would react to many of the recommendations.

As part of this recognition of the need for change, BR appointed Maurice Holmes, then Director of Operations, to the new post of Director, Safety in order to take a long close look at BR's safety performance and culture. His appointment was announced shortly after the publication of the Fennell Report. The Fennell Report was the first major public report to discuss modern safety management methods and BR had realised that it had many of the management shortcomings which resulted in the Kings Cross fire.

It was most unfortunate, in every sense, that the accident at Clapham Junction, which killed 35 people, occurred within 4 weeks of Maurice Holmes' appointment. Whilst in some respects it helped BR focus sharply on many of the problems I outlined above, it also resulted in a full public inquiry with the natural result of such an inquiry

- a long list of recommendations
- no prioritisation amongst the recommendations
- no cost-benefit analysis of the recommendations
- recommendations prescriptive in nature rather than enabling.

Neither BR nor the Government felt politically able to reject any of the recommendations of the Report and the Government pledged adequate funds to enable work to be done ("Additional Safety Expenditure").

Responses by BR

BR's priorities had always been to address accidents which could lead to multiple passenger fatalities. The risks to, and needs of, its staff had not had a high enough priority. It had not recognised that the risk of multiple passenger fatality could not solely be addressed through tighter and tighter operational and technical standards but relied heavily on people's behaviour and conformance to standards.

One of the internal outcomes of the Clapham Junction accident was to focus BR's awareness on these issues. The need for a step change in safety management was recognised. This led to the employment of DuPont, a leading company in safety management, to advise BR on how to change not only its approach but the views of the workforce.

The work with DuPont led to the issue of the BR Safety Management Programme and together with significant Hidden Recommendations, the 1991 BR Safety Plan.

Outcome of Prioritisation Study

In addition, BR required a methodology to control the spend on safety improvement required as a result of the Hidden Recommendations and the recommendations of the study with DuPont It was not acceptable to allow uncontrolled spending in the name of safety.

To this end, BR set up the Safety Investment Panel with a remit to control the spend and develop a methodology to identify priorities and ensure best value for money.

In simplistic terms, the methodology was as follows for each request for investment.

- identify the loss events which the project addresses
- identify the change in loss that the project will bring about
- identify the project cost
- calculate the project safety cost/benefit ratio

The prioritisation methodology involved a very crude process of risk assessment and clearly indicated the need for further development in this area. The Board focused much attention on the need for risk analysis, and particularly quantified risk analysis (QRA). It commissioned a small number of projects but it rapidly became clear that this was a powerful and valuable tool which became more widely applied.

In the meantime, work continued on BR's resignalling programme but with the changes in management of S&T resources required by the Hidden recommendations, it was clear that the programme would have to be adjusted to balance requirement with resource, and hence a process of prioritisation was required.

The "Hesketh" study was set up to identify priorities for resignalling as described earlier. This spun off two additional pieces of work. Resignalling of the London, Tilbury & Southend Division was identified as a high priority but would have to take place in stages whilst the railway continued to operate. QRA has been employed to ensure that the catastrophe vulnerabilities are identified and controls established; a further outcomes will be a model "safety case" procedure for such projects.

In addition a cost effectiveness study was undertaken to evaluate the provision of adequate walking routes as an integral part of new resignalling schemes. The conclusion showed a benefit in building this provision into standards.

Examples of risk analysis projects which have been conducted during 1992/93, with important priority and value-for-money implications, are:

(a) The Hidden Report gave significant support to the Automatic Train Protection (ATP) project and to the acceleration of its development and installation. Work has proceeded to identify a suitable technical system and, in parallel, a safety evaluation exercise has been undertaken, in conjunction with Consultants, to establish the value of the safety benefits delivered, the extent to which this justifies a programme of installation and, if so, in what sequence and to what ultimate proportion of the BR network. The exercise has used QRA principles and has brought a very useful preliminary focus to system size, route priority and value-for-money considerations. The work is currently being sensitivity tested and refined, prior to discussion with DTp to established a strategy for ATP.

(b) A similar type of approach has been made to the vulnerability to major accident or derailment at sites of broken rails and rail welds. Detailed records are kept of the location and types of breaks, and during the year a statistical analysis of rail breaks with type and age of rail has been undertaken for the InterCity high speed routes. There is now available to managers determining track renewal programmes for InterCity a risk based guide to renewal considerations, on grounds of rail type, age and speed usage. Most significantly the study has shown that rails older than 40 years and still in high speed use are prone to much more frequent fracture and are thus a high safety priority for renewal.

(c) Much of the safety benefit of ATP derives from the prevention of Signal Passed at Danger (SPAD) driver irregularities. In parallel with the ATP work, consideration has been given to the feasibility of cost effective measures to mitigate the effects of SPAD incidents. Part of this work concerns crashworthiness to which reference is made. A further important part of the work has focused in 1992/93 on Permanent Way layout configurations and signalling principles.

Briefly, if the design of the railway infrastructure can be so configured to minimise the effect of a SPAD, then it is worthwhile to reconfigure or protect those locations vulnerable to SPADs with catastrophic consequences. During the year a programme of QRA supported work has been undertaken to identify risk locations and to revise signalling principles to mitigate against the effect of SPADs.

(d) Fire Legislation: the post Fennel changes to legislation involve the re-certification of most of the larger BR stations; the Regulations are couched in a highly prescriptive form which if interpreted literally by the plethora of Fire Authorities round the country could impose an enormous financial burden on BR. The Board therefore commissioned QRA on two major London stations and compared the desirable measures of improvement identified by this analysis with those required by the new Fire Regulations. The magnitude of the cost differences was such that steps were taken to gain London Fire Brigade support to a risk based, prioritised programme of fire certification for London stations; the involvement of the LFB in QRA appreciation led to a formal joint agreement to a staged programme of priority works and, importantly, to a Code of Practice permitting sensible interpretation, against risk considerations, of a number of the more costly requirements of the Regulations. This work also allowed BR to make a significant input to the Appleton Inquiry, which resulted in a recommendation that the Code of Practice be endorsed by the Home Office for use by the provincial Fire Authorities. The Appleton conclusion that safety legislation should in future be formulated more on a performance standards basis was fully supported by BR's QRA approach to fire protection.

(e) QRA has enabled the cost effectiveness of a number of the Hidden recommendations to be examined closely. Most significantly, the Hidden 18 Hours of Work standards have been reviewed in the light of an important statistical study of driver error in the context of time at work. By tracking well documented signal-passed-at-danger (SPAD) incidents and lost time accidents through national payroll records of time at work circumstances, a comparative study of driver vulnerability to error has been undertaken, which challenges the present, judgementally derived, framework of Hidden 18 Hours of Work. As a result, the Board has maintained in place its "interim" hours-of-work standards, pending further studies of other work groups, their safety performance and their working hours environment.

This work will form part of the input to H&SE towards their proposal to issue regulations covering train driver hours, and could potentially form a valuable input to consideration of the working hours issues within the European Social Charter.

Meantime, the maintenance of the "interim" standard has obviated major expenditure from having to build in additional rest provisions, as envisaged by the first judgemental approach to hours of duty and fatigue/exhaustion considerations.

It is now useful to return to the prioritisation study.

The result of applying the methodology was a table of projects which showed the computed safety benefit against cost, measured as the amount of safety benefit per £1m spent. Some examples are shown in figure 3 which indicates that the benefits ranged from more than 3 to less than 0.01 safety benefits per £1m spent.

i.e. the costs of preventing a further death ranged from less than £300,000 to more than £100m.

A number of important factors were exposed by this work:

- many of the most effective schemes were relatively cheap
- that those changes imposed by legislation or the recommendations of public inquiries were relatively expensive

An analysis of the costs and benefits fit perfectly into the Pareto principle:

46% of benefit came from 13% of cost
77% of benefit came from 31% of cost
92% of benefit came from 37% of cost

Figure 4 shows this effect with the cost bandings to compare with the figure for road improvement (£0.6m) and then £1.0m, £2.0m, £4.0m and more than £4.0m.

The work has been discussed with H&SE and agreed in principle, and it has also been presented to DTp and HMT but not yet agreed: the parties involved including LUL, have commissioned a comprehensive review of available research, which is still being carried out. In the absence of agreement on any firm maximum guideline, the Board, through Safety Panel, has adopted a practice of examining carefully any scheme that fails to meet a £1m per ELS threshold, and of seeking alternative options to meeting the full expenditure. Where no alternative options have been identifiable and the scheme judged necessary in pursuit of legal obligations, Hidden commitments or the Board's specific safety objectives, then schemes up to the £2m have been approved. An exception has been made for schemes responding to the recent fire legislation, where even higher figures have been accepted.

The basis of this work is the outcome of BR's prioritisation process and the "willingness to pay" principles, involving some of the leaders in this field whose work indicates values of £0.3m to £10m to prevent a death.

It should be noted in this context that, using the same principles of "willingness to pay" New Zealand Ministry of Transport have recently increased their spending on improvements at level crossings by a factor of 10 from the previous figure.

In parallel to the work I have described, BR sought to broaden its basis of safety evaluation work to provide its managers with an insight into the comparative safety performance of BR and indicate the types of analysis and activity that could give significant safety improvement to the industry.

Firstly, continuing work first started in 1991/92, a detailed analysis has been made of the frequency and severity trends (F/N curves) of railway accidents, with a view to pinpointing critical areas of safety performance. F/N Curve analysis is a recognised safety management technique that not only pinpoints differential safety performance but also allows historic and inter-industry comparisons. Together with risk analysis, this type of analysis of BR comparative performance has proved a useful means of focusing priority areas of safety attention, e.g.

- single passenger fatal accidents, where BR performance is poor in comparison with European railways

- multiple passenger fatality accidents - risk of collision through signal overrun

  workforce accidents, where fatality levels of "exposed" workers is high in comparison with other UK risk industries,

so that appropriate effort, resources and money can be directed at these areas of poor comparative performance. The analysis underpinned a number of the Board's specific Safety Objectives in 1992/93 and in 93/94.

The curves in Figure 5 show major changes in risk performance post-1947 and the modernisation but since then little change in the rate for single, or low number of passenger fatalities, the improvement is at the high-multiple end, brought about largely by improvement in carriage design.

Secondly, BR performance has been compared with available H&SE advice on tolerability levels of risk and resultant safety performance; the adoption of H&SE "ALARP" principles to specific areas of BR performance is seen to be a justifiable means of focusing response to safety objectives. Such an approach has highlighted:

(a) the contribution that improved door safety can make to the overall safety of individual passengers in transit. From this has stemmed during the year a worked-up programme of slam door stock improvement, comprising the progressive introduction of modified door locks, improved maintenance and train despatch arrangements and, for InterCity slam door stock, the introduction of door bolt arrangement which prevent a slam door opening whilst the train is in motion. This costed programme has been evaluated against the Board's safety benefit guidelines, and will deliver over 3 years a substantial improvement in passenger safety.

(b) The poor comparative safety record amongst rail trackside workers, where performance approaches the minimum tolerability levels acceptable to H&SE for exposed workers. This has prompted an industry priority for the take-up of the Safety Management Programme by track workers, their supervisors and managers, and in particular the implementation of pre-work briefing, safety meeting and safety walk-abouts and inspections. The marked reduction in trackside fatalities in 1992 would seem to vindicate the focused effort and expenditure incurred. The Board have further attached special priority to a detailed examination of safer ways of arranging and supervising trackside engineering - the Eccles Project. The report, now to hand, makes proposals for long term improvement of trackside safety to levels within H&SE minimum tolerability limits, and uses safety benefit appraisal to justify its principal recommendations. The recommendations will form the basis of a major evaluation and implementation project during 1993.

(c) The frequency of major rail accidents, involving multiple loss of life which, at about 1 every 15 years, now compares unfavourably with other risk industry aims of achieving frequencies of better than 1 in 50 years for major accidents. This has highlighted the areas of catastrophic vulnerability of railways: engineering, design and installation/construction, operator error and maintenance shortcomings, and has prompted careful consideration of catastrophic risk reduction in these areas of activity, through the introduction of rigorous work systems which underpin high quality, compliant behaviour.

Thus the Board's Supplier Accreditation and BS 5750 Quality Assurance initiatives are seen to have a place in contributing to safety objectives and have been subject to safety expenditure and benefit evaluation.

The mitigation of the effects of potentially serious incidents by improved crashworthiness of rolling stock is also seen to be an important contributor to this area of safety, and the Board has supported a programme of investigative work here, and again against safety expenditure and benefit guidelines, some changes in design standards.

(d) The need to review the safety arrangements for the conveyance of hazardous materials by rail, where concerns over the age of many of the tanker fleets and a series of recent axle bearing incidents prompted the Freight Business to investigate, on an objective risk basis, the safety performance of railing hazardous materials in comparison with H&SE guidelines. The work confirmed the overall acceptability of rail operations but recommended that catastrophic vulnerability be improved via a simple upgrading of axle bearing examination and maintenance arrangements; a focused and cost effective response to a low probability but high consequence risk.

other work which had come out of the most recent BR reorganisation, O for Q on the Standards Organisation, safety validation of change and competency continued to focus on BR's needs and ensure in these areas, too, there was (and is) the best return possible on management effort and expenditure.

Further Developments

While the safety appraisal method was appropriate to the temporary arrangements of Additional Safety Expenditure, it is not sufficient to deal with the needs of safety within the integrated decision making of the normal business planning and budgeting process which will apply from 1993/94 onwards. With the help of the same Consultants, the Board embarked on a programme to develop a procedure of safety expenditure appraisal for use on the longer term.

The results extend beyond the strict confines of safety to provide an integrated approach to more general expenditure decision making. The study has shown, with considerable participation by the management groups, that if the Board is to address effectively both commercial and safety concerns, it will be desirable to adopt an objectives orientated approach to decision making in which items of expenditure are considered in terms of their contribution to the objectives of the Businesses in a clear and justifiable way. The approach provides a framework for a rigorous process, both for establishing the objectives and for determining which schemes and activities should best be carried out in order to meet those objectives. It encourages devolution of responsibility and authority which permits management teams to establish their own objectives while taking into account influences from higher authority and external obligations in a structured way.

In this sense, the approach is consistent with O for Q, and as far as may be envisaged is not inconsistent with the future structure of the industry. The application of the approach has been successfully demonstrated during a pilot study on the LT&S Division of NSE during 1992, and its cardinal elements have been communicated to the Profit Centres and used in outline as part of the risk scanning exercise in the 1993/4 Business budgets. The approach will be progressively exposed to management terms during 1993, with appropriate training and support.

The longer term approach, described above, still requires the Board to provide guidelines on value of life on the railways. The Board's upper figure of £2m per equated life saved (ELS), first discussed with DTp early in 1992, has been reviewed, compared with practice in other industries and with published research work.

But BR has to be aware not just of its "absolute" risk performance but also how its safety performance is perceived by the outside world. For example, it may have to apply weighting factors on its risk reduction spend to reflect public aversion to certain types of incident

- rail incidents, no matter how severe
- multiple fatality accidents
- size of accident
- cause of death
- note aversion e.g. to radioactivity

BR is undertaking a range of studies with the University of East Anglia to identify significant risk aversion factors so that these can be injected into the debate.

It is already clear that different modes of transport carry different levels of risk. Broadly speaking, all modes of public transport are very safe as far as their passengers are concerned. The Royal Society document on "Risk analysis perception and management" shows that over 4 year periods the relative risks from travel by road and rail were as follows:

	1967-71	1972-76	1986-90
railway	0.65	0.45	1.1
car and taxi	9.0	7.5	4.4

Deaths per 10^9 kms travelled

Note that even in the worst 4 year period which included both the Kings Cross fire and the Clapham Junction collision, rail is 4 times safer than car or taxi transport. In the other periods it is about 15 times safer.

All this must influence the investment level for safety on the railway. It is already a very safe means of transport and objectives have been agreed which will deliver further improvement at reasonable cost. If rail is to be made safer still it will:

- drive in additional cost
- raise fares
- force passengers onto roads
- increase overall risk of death

Target Risk Levels

From the above it is clear that in order to manage railway safety it is necessary to set target risk levels. But it is also clear that the target risk levels must be cost effective, both in terms of the cost of achieving them and in not making the railway so expensive that people change to higher risk forms of transport.

We are now building significant new railways for the first time in a generation and decisions also have to be made on the risk criteria for design, construction and operation. These railways will not come into operation until the turn of the century.

It is clear that it is no longer acceptable to build to outmoded, prescriptive standards which do nothing to advance the cause of safety but which at best freeze standards at the current level and prevent innovation.

These principles throw up a series of challenges some internal to BR and some of a wider nature:

Internal

- BR must seek a balance between safety investment and commercial investment to meet its overall objectives in a balanced way

- BR must control the risk brought about by continual reorganisation with further diversion of management attention from the safe running of the existing railway

External

1. New Railways

   - the current principle is that they should be no less safe than today but it is possible to reach much higher standards when starting from scratch with very little additional outlay

   - What standards should be used for comparative purposes
     - dedicated high speed track e.g. TGV?
     - mixed traffic?

2. How far should BR take public perception of risk into account? This is in a background of political decisions on investment and the legal implications of safety legislation defined in terms of reasonably practicable. How much should be spent to prevent incremental deaths and injury?

3. How should we react to another "Hidden" inquiry where recommendations may be made without risk analysis or cost benefit analysis? Should terms of reference for such inquiries be much more tightly phrased?

4. The cost effectiveness of national safety legislation must be much more clearly defined. Despite the H&SW Act, much legislation is still arbitrary and prescriptive chasing the most recent accident viz sub-surface station regulations:

   - regulation requires a goal setting methodology with the goal clearly described and understood and adequate cost benefit analysis undertaken before introduction, rather than justified later

5. There needs to be a level playing field for all parties in setting standards and agreeing activities to meet those standards. This does not necessarily mean the same threshold of spend or value of life, but must mean that competing modes of transport use a common set of principles from which cost/benefit can be calculated in a consistent way.

Summary

BR is a long established organisation that had become thoroughly inward looking. As the biggest UK railway operator it believed it set the standards and so became complacent in its safety management. It didn't challenge itself enough.

After Clapham it felt itself politically unable to reject the recommendations of the public inquiry. This led to some diversion from its developing risk management approach.

A great deal has been achieved since then on budgets, investment prioritisation schemes and in developing internationally comparable standards and practices. This process is summarised in Figure 6. We are still in the learning process but we now need some guidance as to acceptable levels of railway safety performance.

- what should be the safety performance of the existing railway and what in new railway

The Railways (Safety Cases) Regulations will require new operators to state their safety performance levels and they may challenge accepted wisdom

- if an appeal against safety validation refusal is made to the Secretary of State for Transport, he will be required to set such performance levels.

Figure 1

TOTAL PASSENGER FATALITIES

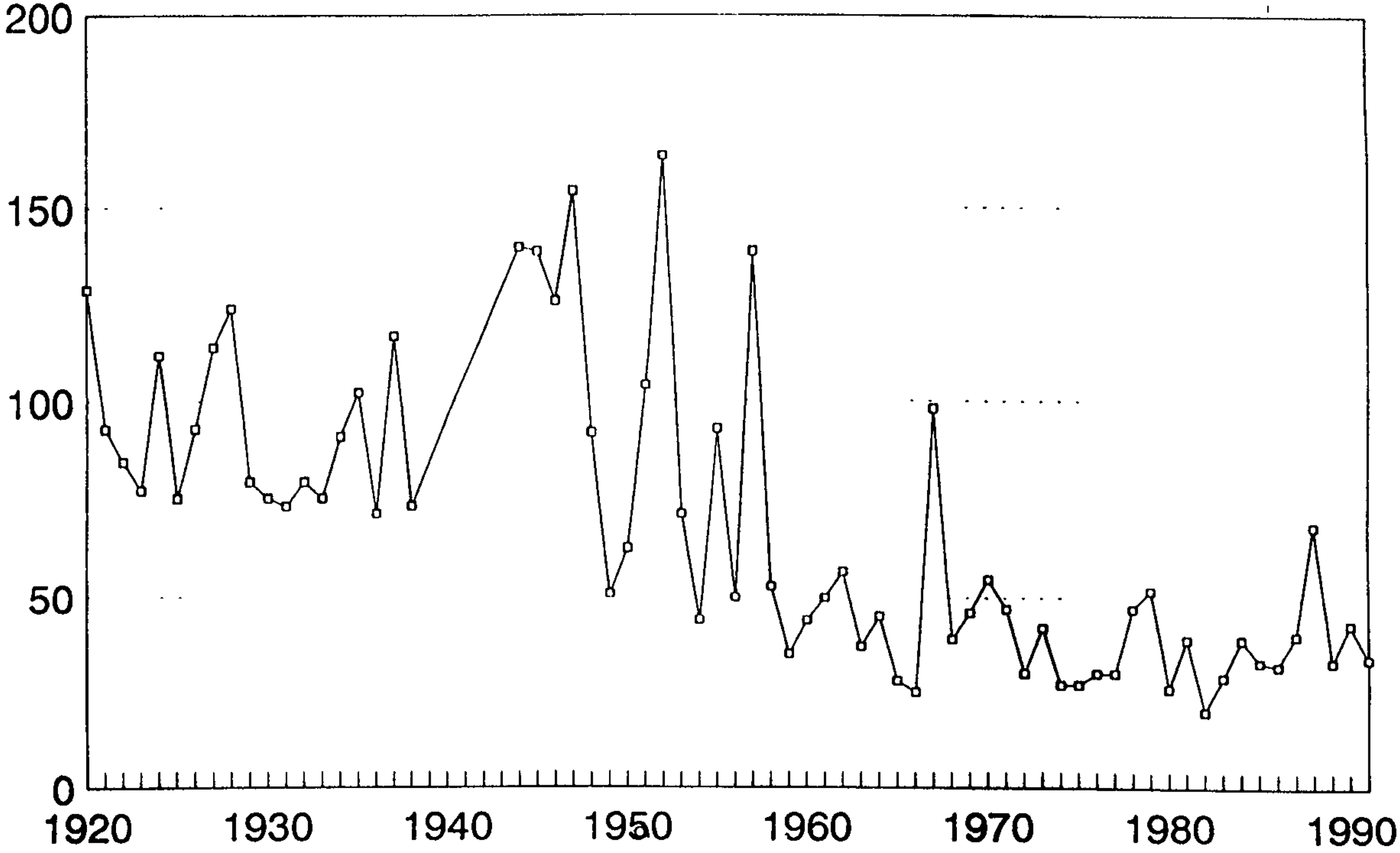
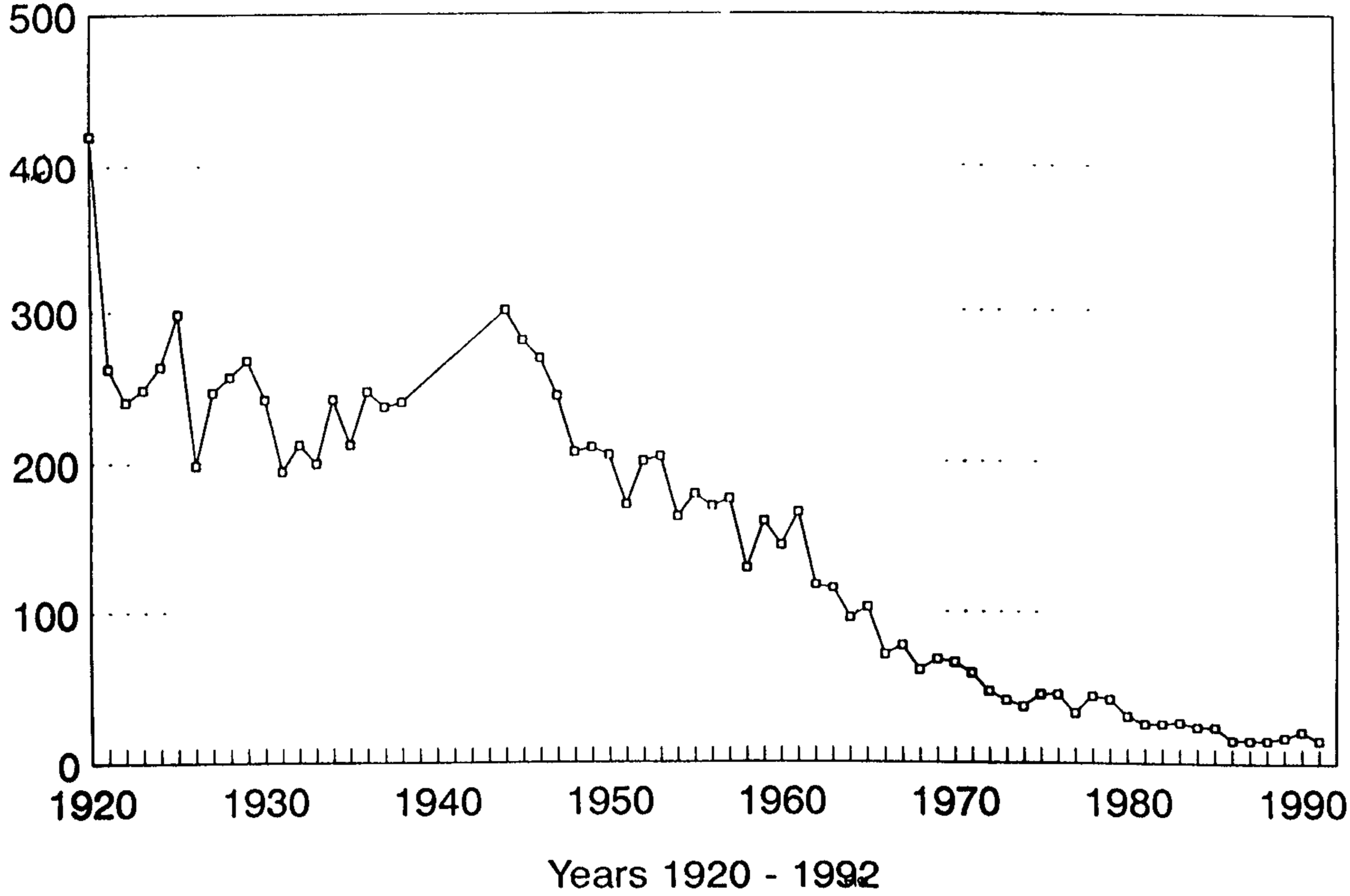


Figure 2

TOTAL STAFF FATALITIES

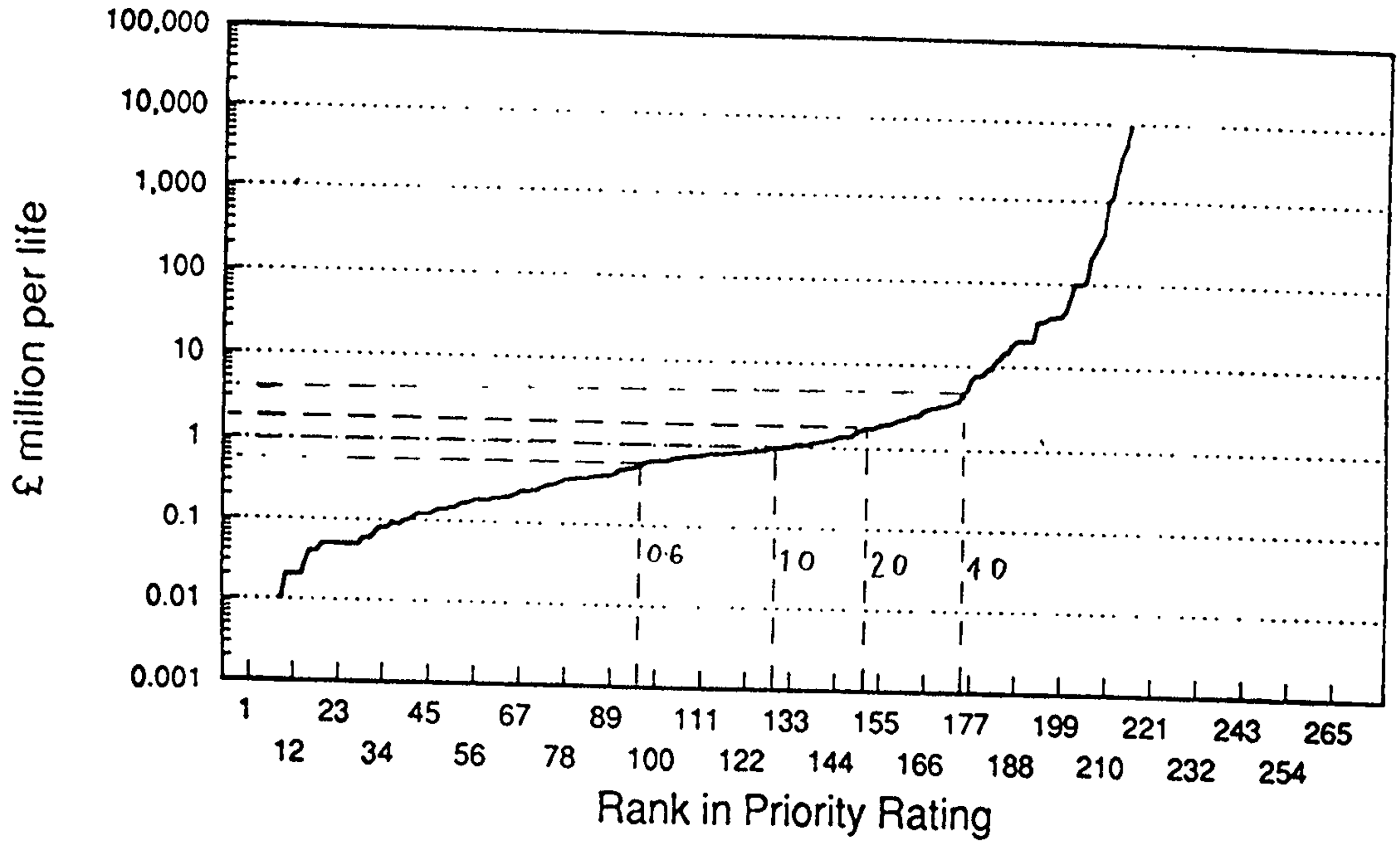


SAFETY PROJECTS

Project	Safety Benefit	Cost/Death Prevented (£m)
Safety fencing	15.6	0.064
Safe work procedures	11.3	0.088
Maintenance Manuals update	6.51	0.15
Additional ultrasonic testing	4.43	0.23
Power door mods	3.5	0.29
Stepboards on Parcels vans	2.65	0.38
Addn. cable & track inspections	2.1	0.48
Fire training initiatives	1.59	0.63
Bridge scour repairs	1.38	0.72
Operation Safe Cess	1.02	0.98
Lighting on ballast hoppers	0.93	1.08
Operation Clean Sweep	0.88	1.14
Radio band conv II/III	0.74	1.35
Safety of station lighting	0.72	1.39
Public address system	0.52	1.92
Enhanced braking	0.41	2.43
Waterloo & City fire precautions	0.32	3.12
Parcel van rebogieing	0.30	3.33
W & C fire comms	0.16	6.3
Prevention of Legionnaires disease	0.13	7.7
Liverpool St fire precautions	0.09	11
Merseyrail fire precautions	0.05	20
Birmingham New St fire precautions	0.01	100

Figure 4

SAFETY BENEFIT EVALUATION



Figı

F/N CURVE - TOTAL FATALITIES 1920 - 1992

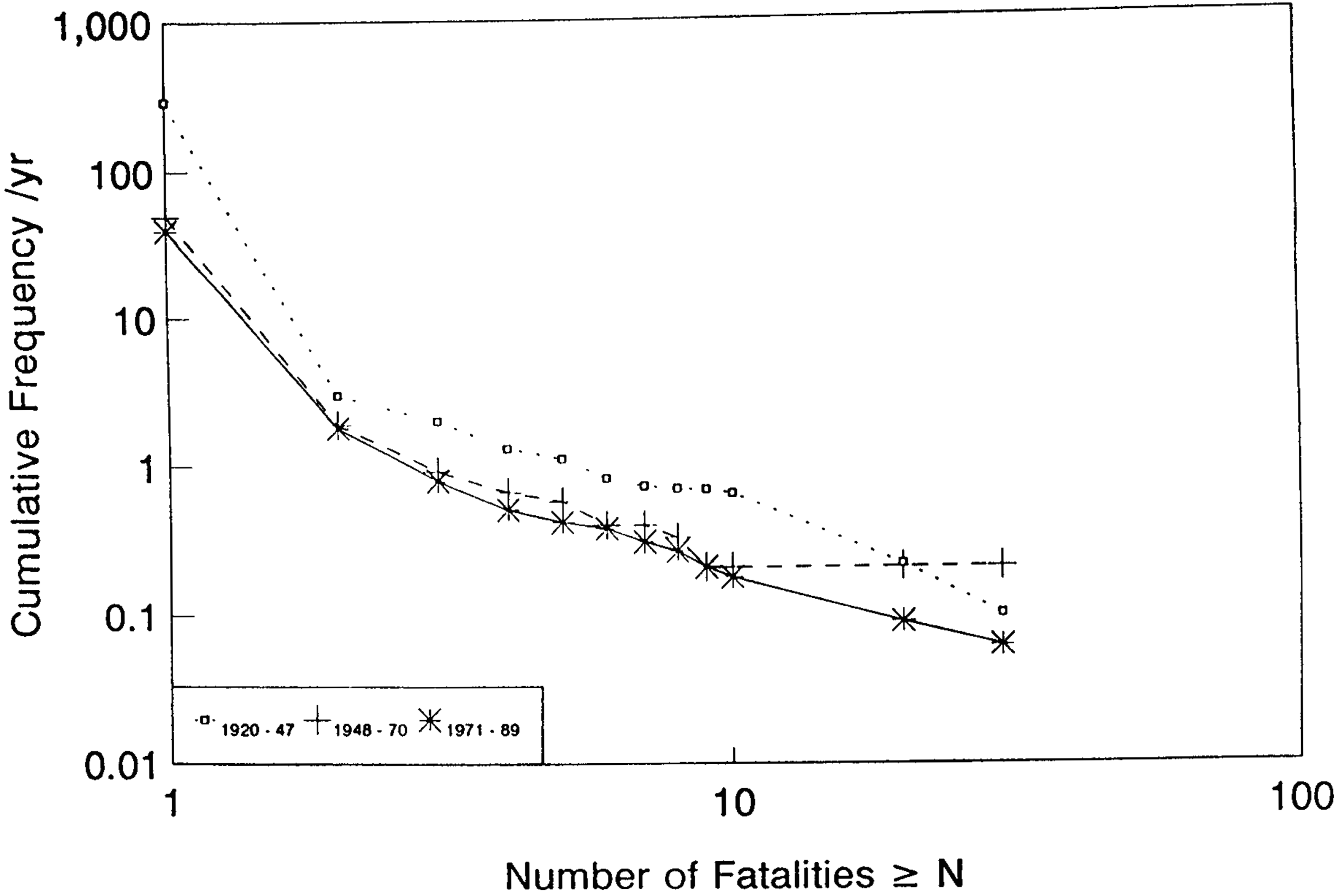
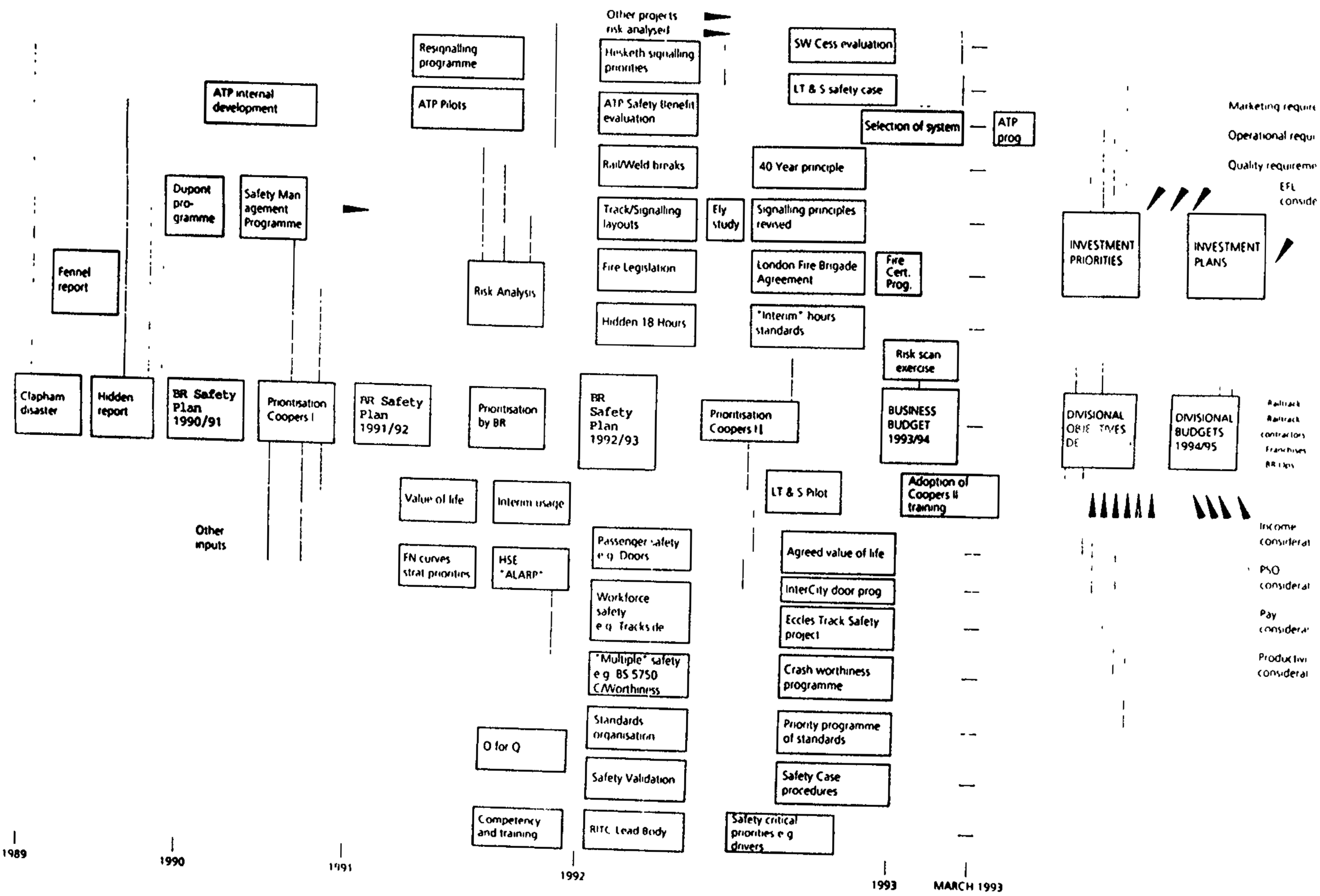


Figure 6

DEVELOPMENT OF RISK MANAGEMENT IN BR



"SAFETY CASE"

Definition

A document by which an organisation sets out to demonstrate its ability to conduct a particular operation or activity in an acceptably safe and proper manner.

Safety Case Contents

The document would normally include:-

a description of the activity concerned

an identification and evaluation of the risk involved, including qualitative and, where appropriate, quantitative assessments

a description of the Safety Management System demonstrating how those risks will be mitigated and controlled to ensure an acceptable level of safety.

"Guidance Note"

The term "Safety Case" is *well* used *in general industrial* safety jargon. It is often prefixed e.g.

Nuclear Safety Case

Off-Shore Oil Safety Case, or

Railway Safety Case

The principles of safety cases are the same, it is only the application that differs.

There are, however, a number of "dimensions" applicable to the term "Safety Case", there are dimensions of time, place and depth.

"Time"

A "Safety Case" is written at a particular point in time. It may demonstrate the safety of the specified activity as operating at that moment, or at the moment in which the activity commences if it is a new operation.

It is, however, a living document, i.e. it should be updated as appropriate so that the safety of that activity always has a current document against which it can be Safety Validated, or Audited.

This means that from time to time a significant change may be proposed to the activity. This could come about through an Investment Project, a change in management structure or organisation, or change brought about by significant changes in the market. Subjecting this change to a "Safety Case" is a perfectly valid application. In this situation, it would normally identify and measure the risks and variation in safety performance envisaged to be brought about by the change, and the effect that these will have on the ongoing safety of the activity. In other words, it forms an "amendment" to the "Safety Case". If the implementation of the change itself incorporates safety risks (eg a major construction project) this too would be subject to the "Safety Case" process.

In this latter situation - i.e. when a major change is being proposed - it may be relevant to produce "Safety Cases" at different stages of a project, eg a "preliminary" Safety Case to outline options and then safety implications during the design or initial approval stage of a major project. A more detailed and comprehensive "Safety Case" may then be prepared at a later stage when the initial planning decisions have been made and thought through.

"Place"

A "Safety Case", of course, may be applied to many industrial activities or many locations. It may apply to one particular aspect of an activity or to a "whole" activity.

Therefore, it is quite appropriate to find terms like "Railway Safety Case" or "off-shore oil Safety Case". The term means the same. The application is different.

On the railway, we have already applied the term, quite correctly, to a number of activities very different in scale and geographical coverage, eg:

> The Trainload Freight application to the localised flow of hydrocyanic acid in the Billingham area.
>
> The NSE application to the LTS Division, with inclusion of the major change being brought about by the resignalling proposal.
>
> The preparation by Union Railways of a "Safety Case" for the proposed new high speed railway between the Channel Tunnel and London.
>
> The proposed EPS "Safety Case" for certain activities (ie train operation) for which they will be responsible after the opening of the Channel Tunnel, which might include interfaces not only with other BR Businesses, but also Eurotunnel, SNCF and SNCB.

"Depth"

The detail of the "Safety Case" should be appropriate to the risks identified, or the significance of changed operations proposed. One could, in theory, produce a "Safety Case" for very simple acts like operating a Wordprocessor, or moving parcels on a platform. The resultant document would be short - perhaps one or two pages - and the risk assessment would be descriptive, or if quantified, using a simple ranking system like the "5 by 5" matrix commonly used on BR as taught on the Hazard Management Courses.

At the other extreme, a new railway operator may wish to propose revolutionary modes of operation in safety critical areas, or a new technical facility of some complexity may be under consideration. In these cases, a degree of "Quantified Risk Assessment" may be expected within the "Safety Case", perhaps of a fairly sophisticated variety.

"Use"

A railway owner, operator or manager may wish to produce a "Safety Case" for a variety of valid reasons. Some of these are given as examples below:

To demonstrate to himself that a hazardous activity is under proper management control.

To ensure safety is properly considered in the design or planning of an activity.

To ensure that expenditure or investment is cost-effective, i.e. that safety measures are appropriate to risk, neither inadequate or unnecessarily excessive.

To meet internal BR, Railtrack or Business management requirements as part of a Safety Management System.

To meet "Railway Safety Case" legislation, for Validation purposes, as proposed under the Railway Privatisation Bill.

To meet other legislative requirements.

To control a "high risk" activity, or use as part of a process to improve safety in an activity where safety performance has been of concern to management or staff.

To allay public or media concern, to demonstrate whether this is substantiated or not, and identify appropriate communication strategies.

"RAILWAY SAFETY CASE"

In light of the above explanation of safety cases, we can simply define a railway safety case as:-

"A Safety Case prepared pursuant to regulations 3,4 or 5 of the railways (Safety Case) Regulations 1993".

end

International Rail Safety Conference

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9308 Part 2

David Rayner
David Maidment

An approach to taking Public Perception of Risk into account, in setting a "Value of Life"

Publisher
2000 International Rail Safety Conference

International Railway Safety Seminar

Angers, France, October 1993

An Approach to Taking Public Perception of Risk into account, in setting a "Value of Life"

Paper by D E Rayner/D J Maidment, British Rail

Value of Life

From the analysis of the results of the prioritisation of the "Additional Safety Budget" portfolio of projects, it was provisionally agreed that BR would use a "Value of Life" (VoL) of £2 million per "weighted" safety benefit to justify safety expenditure proposals.

This was established by identifying the point at which the cost-effectiveness of projects dwindled sharply, and by an analysis of the effect of applying different thresholds and assessing the results, eg:

VoL	% of Total Safety Expenditure	% of Identified Safety Benefits
£600,000 (Road VoL)	15%	45%
£1 million	30%	77%
£2 million	45%	92%

The remaining 55% expenditure included many "high profile" projects, required to meet the public commitments given to the Fennell and Hidden Inquiry recommendations.

BR decided to allow safety expenditure to be justified when the VoL was better than £1 million per "SB"; to allow expenditure after exhaustive consideration of options and checking of analysis, when VoL was between £1 and £2 million per "SB"; and to reject expenditure over £2m per SB, unless there were significant other considerations (eg compliance with legal requirements). HSE and DTp were advised accordingly.

Whilst this guideline was implemented during the 1992/3 and current budget years, the Safety Policy Unit advised you that academic research existed which would support a more sophisticated calculation of the VoL threshold. In particular, the public aversion to risk of multi-fatality accidents, and accidents where the risk-taker had a very low control over that risk, suggested and supported the higher BR valuation of life. However, for some individual types of accident, the agreed DTp "road VoL" was appropriate.

The suggested values were:

£700,000 (Road VoL updated for inflation	:	Members of Public on BR Property (eg Stations, Level Crossings). Passengers on trains where own actions were involved in risk taking (eg joining or alighting from moving trains). Employees in normal work situations.
£2 million	:	Members of public in neighbourhood of railway (at risk from derailment, release of toxic vapours, fire etc following any accident) Passengers involved in train accidents. Employees exposed to high risk because of the nature of their duties (eg trackside workers where BR had a special duty to ensure safe systems of work to protect staff safety.

The Policy Unit also postulated that there could be further variations from these two norms, eg

i) a lower value (? 50% of Road VoL) for members of public and passengers deliberately placing themselves at risk (vandals, trespassers, suicides).

ii) a higher value (£2 million x aversion factor) when "catastrophic" risk coupled with perceived public anxiety were potentially present (underground fire/flooding; major accident involving release of toxic fumes or radiation).

As a result of this, the Safety Policy Unit commissioned a study by the Environmental Risk Unit of the University of East Anglia (UEA) to research literature on the subject and recommend a VoL methodology for BR that took public perception of risk into account. A draft report from UEA is now available supporting the concept that single VoLs based on economic criteria, or "willingness to pay" by the individual are inadequate, and that the VoL should also be influenced by the risk performance of the transport operator and a number of well recognised public aversion factors. The report concludes that it would be appropriate for BR to pioneer the development of such a methodology.

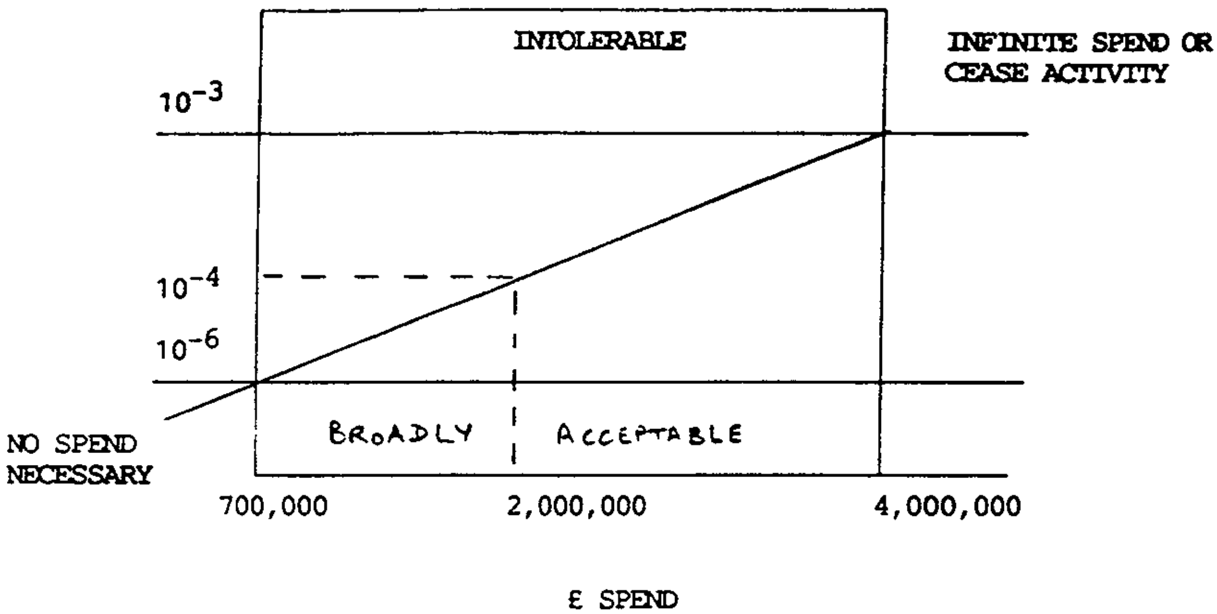
The Policy Unit has considered the relevant research and factors concerned, and has an "embryo" VoL process which we believe should be developed and used, initially, as a "sensitivity test" to the application of the existing and agreed BR VoL of £2 million per life saved.

The proposed VoL would be made up of three ingredients:

1. A base (Utility) value reflecting agreed DTp/Treasury values for the Road Industry Cost Budget Analyses (currently around £700,000 per life saved).

2. Multiplication by a factor based on existing risk performance for the group of people affected by proposed expenditure, eg:

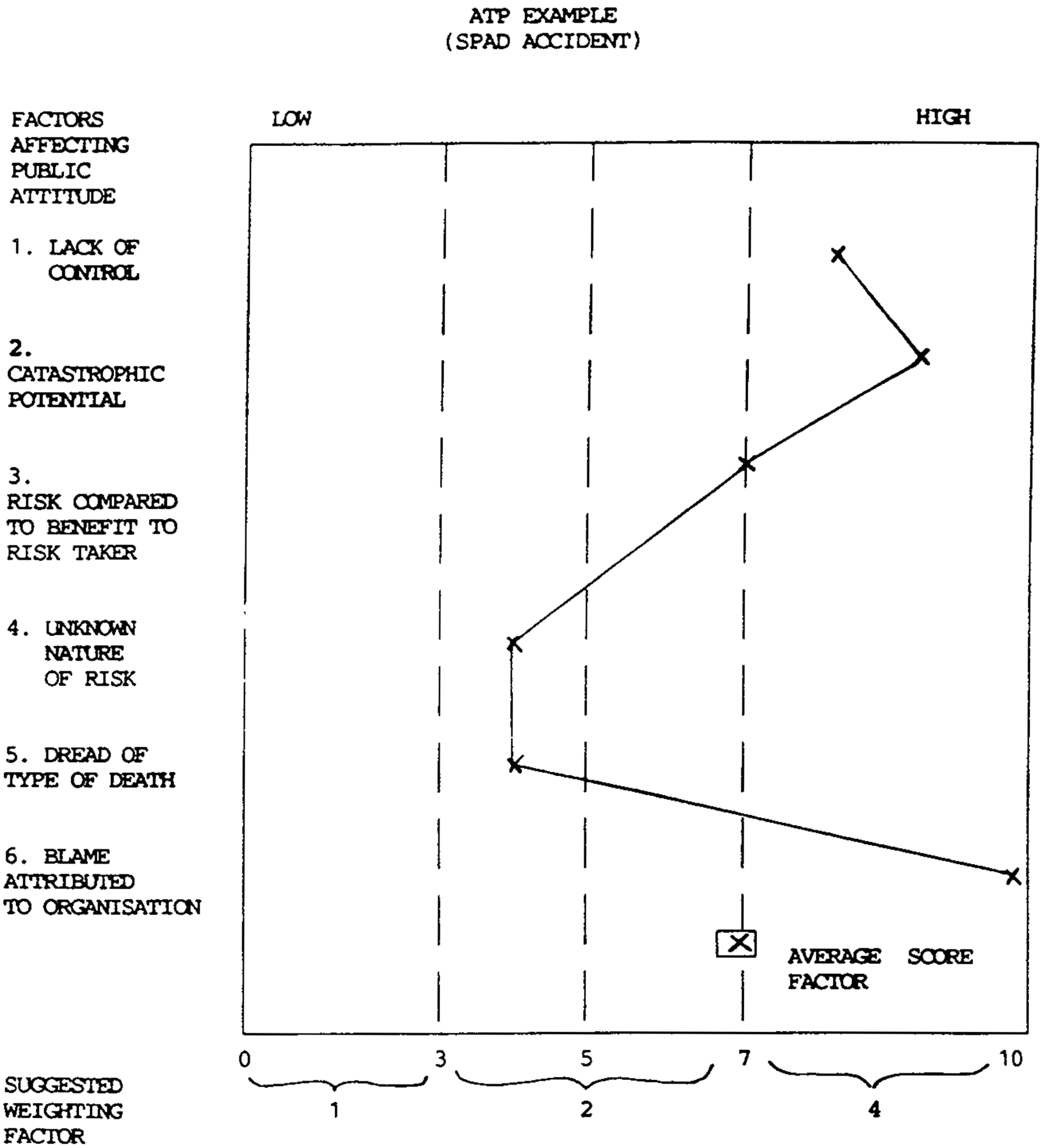
(EXAMPLE FOR EMPLOYERS)



WEIGHTING FACTOR	1	2	4

(The figures are tentative; there is an argument that 10^{-4} should equate to £700,000 and 10^{-3} to £2 million).

3. Multiplication by a factor based on a mean of scores (on a 0 - 10 scale) used to evaluate public attitude to risk in the transport industry, eg



If we concluded ATP would avoid train accidents where BR performance was around the "benchmark" for societal risk, and between the benchmark and broadly acceptable level for individual risk, we would get a VoL of :

(ATP example)

Base Value		Tolerance Factor		Aversion Factor
£700,000	x	1.5/2	x	3

ie in a range from £3m - £4m.

The "Value of Life" methodology discused excludes other loss control factors that relate to Business decision-taking, eg

Asset damage costs
Train disruption effect on revenue
Legal and administrative costs
Environmental damage costs.

Compensation costs to employees and public are included within the Base (Utility) Value of Life.

Recommended Way Forward

1. Agree some provisional numbers for the Factors with UEA that are commensurate with research experience.

2. Test for sensitivity on a number of BR expenditure/project proposals.

3. Test with a number of Groups:

   - Research/Academic field, including J Reason, and "Bad Homburg Network" of Risk Management "gurus".

   - Other industries, particularly UK players in this field identified at AEA conference on Cost of Accidents (Nuclear Electric, MoD, Steel, Shell, BP, National Power). Also test at World Congress of Safety Science (Budapest, November 1993).

   - Other Railways, via Angers Conference, also regular meeting of Safety Directors of Western European Railways (SNCF, DB, SNCB, SBB, NS).

   - Senior BR Managers

   - HSE/Railway Inspectorate/DTp

4. When an "acceptable" set of numbers is agreed as a working hypothesis, use the system in parallel to the £2 million value, as a "Sensitivity Test" to set a range of values for testing options.

5. Commission research by UEA (or another consultancy), to seek support for numeric weighting factors in the transport environment - a joint sponsorship, if possible, with HSE and/or DTp.

D J Maidment
Safety Policy Unit

International Rail Safety Conference

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9309

Hiroshi Nagaoka

The accident/incident database and risk assessment study at JR East

Publisher
2000 International Rail Safety Conference

International Railway Safety Seminar 1993

THE ACCIDENT/INCIDENT DATABASE AND RISK ASSESSMENT STUDY AT JR EAST

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The Accident/Incident Database and Risk Assessment Study at JR East

Hiroshi Nagaoka
Director, Safety Research Laboratory
East Japan Railway Company

1.Outlines of JR East

JR East is one of the six Japanese passenger railway companies which were established by partition and privatization of the former Japanese National Railways(JNR) in 1987. The followings are the outlines of the company's assets and activities:

-number of staff	80,700
-service line kilometerage	7,500
-number of rolling stock	14,200
-train kilometerage	722,000/day
-passenger kilometerage	352,000,000/day
-annual fare revenue	1,740 billion yen

2.Efforts toward a higher safety level

Safety is a vital question for JR East to survive as a private company. JR East explicitly ranks safety the top priority of the enterprise and has taken measures for safety in the form of investment, institution and campaign.

(1)Investment

Approximately 20% of the total annual investment is applied to safety improvement according to the 1989-1993 safety investment plan which assigns 200 billion yen as the total term budget for safety measures. The budget is itemized as below:

-Introduction of ATS-P(patternized automatic train stop)	550 billion yen
-Upgrading of level crossings	300 b. yen
-Natural hazard prevention	200 b. yen

-Construction of operation control computer systems	350 b. yen
-Other safety measures	600 b. yen

(2)Institution

Safety Research Laboratory was founded in 1989 to encourage safety related R & D activities by inhouse safety experts and 10 General Training Centers were established also in 1989 which are in charge of in-service training of drivers and signal operators in each local area.

(3)Campaigns

For safety, motivation of the front staff is no less important than measures by equipments and institutions. "Challenge Safety" is a unanimous enrollment in which participant front staff have the opportunities to think, propose, discuss and practice in their tasks what are needed for safety In addition, the company executives have regular meetings with the front staff twice a year to understand specific safety problems at each work site to reflect them in their managerial decisions.

(4)Number of collisions and derailments

	1987	1988	1989	1990	1991	1992	Total
Collisions	0	1	0	0	0	1	2
Derailments	4	7	7	2	3	5	28
(at level crossings)	(3)	(6)	(2)	(1)	(1)	(2)	(14)

3. The accident/incident database

It is important to take safety measures based on the analysis of historical major accidents so that recurrence of the similar accidents would be prevented. This has been the way how efforts for reduction of accidents have been made at JNR and JR East up to the present. But now that the total accident rate is fairly low as shown in the above table, it is easily understood that the total accident rate cannot be reduced beyond a certain horizon by mere follow-up of past accidents. Therefore safety measures henceforth should be taken on the basis of statistical and individual analysis of incidents or accident initiating events including the ones that did not propagate to serious accidents. For this purpose, JR East has developed a database system which accumulates 60,000 accident/incident data since establishment of the company.

(1)Outlines of the database system

There are 9 branch offices which take charge of daily train operation in the whole area of JR East. Each branch office has its own transport safety division The major tasks of the transport safety divisions are:

-proposal of safety measures appropriate to the state of arts of the local region
-guidance to local workshops
-preparation and storage of accident/incident reports

The accident/incident reports record not only accidents but also violations of operation rules, delays of trains due to facility failures. In spite of their unquestionable validity as the fundamental accident data of the company, the existing accident/incident reports have the flaw of the inconvenience to refer and compile the data because they use paper sheets and are handwritten.

The newly developed accident database system enables quick reference and processing of the original data for any purpose. The database system is composed of the head office subsystem which is made of a large sized computer and two terminal personal computers placed in the head office and the Safety Research Laboratory, and nine branch office subsystems which functions as regional databases.

(2)Input items

Input items of the database are selected as below in consideration of the convenience of data reference and processing.

-Fundamentals(place, time, type of accident, train number, weather, related branch office)
-Contents of accident(state of affair, causes, locations of failures)
-Related persons(vocational position, age, workshop belonging, background factors)
-Casualties(number, causes)
-Operational turbulence(suspension, delay)

There are some input items which have been added later on in consideration of user's concern about specific accident cases such as:

-Signal overrun
-Signal failure
-Correlation with maintenance work
-Brake failure
-Correlation with signal changeover work

All these input items are classified and recorded according to their code numbers. Literal data up to 30 Japanese letters can be also input to each accident record to make the data profile readily understood

(3)Functions of the database

The database system has the function of three dimensional graph display in addition to reference and processing of the designated code data. The system can also jointly work with the current facility database system. So one can refer to the dimensions of the proper level crossing while displaying certain level crossing accident case.

(4)Scanning of image data

The accident/incident database uses 84 input items and 30 Japanese letters to describe the contents of each accident/incident record. The format is of convenient size for usual statical analysis but not suitable for individual study of the details of the accidents especially on the attributes which are not given codes for reference. For this reason, upgrading of the system has been made so that it can store the handwritten accident/incident reports as image data. Storage of 60,000 accident/incident reports from 1987 to 1991 has been completed and the function of reference and printing is available.

4. Risk assessment study

On the basis of the accident/incident database system as one of the working resources, a study about the application of probabilistic risk assessment(PRA) to railway safety is anticipated at the Safety Research Laboratory.

(1)Why PRA?

The railway belongs to the technologies of the nineteenth century by its origin. Those technologies have developed from a small scaled, primitive and fanciful stage acquiring their performance with reliability and weeding inconvenient properties out through countless experiences of failures and accidents. For this reason or others, it is still the principal policy of safety measures in railways to learn from the history Namely, "Do not repeat the same fault." is the fundamental rule of the thought. When the decisions of safety measures are made according to this policy, it usually occurs that countermeasures to avoid the recurrence of the scenarios of the accidents which occurred close to the decision maker in time, place and perception tend to be taken overwhelmingly before the memory of the accident fades out. On the other hand, the accident scenarios which were not realized but might have more or less possibilities of realization under different conditions or those accidents which occurred "far" from the decision makers are largely neglected to be taken into consideration. Those who are engaged in the safety affairs have felt this uncomfortable but it has been also true that this corrective safety policy has been effective enough as long as the accident rate of the concerned system is rather high and consequences of individual accidents cannot be intolerantly serious for the enterprise and the society.

In the latter half of the twentieth century, however, there emerged numbers of new technologies which have such remarkable characteristics as expansion, limitation and complication which do not allow the system to rely upon mere corrective safety measures. These new technological systems, nuclear power plants for example, cannot be accepted by the society unless there are the evidences that the systems are inherently safe in the meaning that any intolerable accident scenario will never be realized out of the systems even if it should be supposed.

PRA is a relatively new technique which has been widely recognized to be useful for safety assessment of the typical modern technological systems. In contrast with the traditional deterministic safety assessment methodologies, which picks up small number of typical accident cases for safety tests, PRA considers all loss events which have any non zero probabilities of occurrence of not only the actual historical accidents but also the imaginary ones. The strength of PRA is that it can estimate the safety of systems in total and in a priori using the concept of risk, which gives the way to discount the undesirability of the any uncertain events in proportion to their probabilities.

It is readily supposed that the application of PR' will bring a lot of benefit to the railways considering how much their technologies have developed in the recent decades.

(2)The targets of PRA

The requirement in the general PRA is composed of simple concepts. It is to answer the following questions:

-What can go wrong?
-What are the causes?
-What are the consequences?
-How likely is it?

The ultimate purpose of the application of PRA is to provide methods for consistent decision makings of selecting the best safety measure alternatives under the given circumstances by estimating the state of risks and comparing them with the safety goal levels.

(3)Procedures of PRA

In our study, PRA will be carried out according to the following procedures.

1)Loss attribute identification

To begin with, we identify the space of loss attributes which the accidents we are to survey belong to. Preliminary researches about existent PRA results suggest that it is appropriate for fruitful applications of PRA that the study focuses on such fatalities that can bring any blame to JR East. Pure financial loss events with no fatality and fatalities caused by the victims themselves are to be excluded from the objects of the study.

2)Accident sequence identification

All conceivable initial events to accidents are numerated and their propagating sequences are classified to make it sure any important accident scenarios should not be omitted.

3)Consequence analysis

The consequence of each identified accident scenario is estimated in terms of number of fatalities and financial loss

4) Frequency analysis

The frequency of each identified accident scenario is estimated in terms of any appropriate numerical or linguistic expressions.

5) Uncertainty analysis

The uncertainties of the estimations obtained from the above consequence and frequency are evaluated in terms of confidence interval or any appropriate linguistic expressions

6) Risk measurement

We anticipate quantitative risk measurement based on the above consequence analysis, uncertainty analysis and frequency analysis. Numerical definition of the risk of an accident scenario may be written in the form of:

Risk=(Probability) × (Consequence)

In order to assess variant risk aspects of the system, the quantified risks of individual accident scenarios will be processed into such risk factors as system total risk, contribution of individual risk to the total risk, risk contribution of uncertainty, and so on.

(4) Directions of study

Analysis of peculiarity of railway risks, subjective weighting factors of perceived risks and accident probability estimation are the major study topics we are now involved. On the basis of these individual studies we would like to construct a sound framework of the railway PRA

1) Railway peculiarity

Natures of the procedures and targets of PRA should differ in accordance with the peculiarity of each concerned system For example, the nuclear reactor PRA focuses on the risk exposure of the society as a whole or public risk acceptance and takes fatality rate profile as the sole risk measurement. This way cannot be applied successfully as it is to the railway. Because there is little question about whether the railway should be accepted by the society or not, cost-benefit efficiency of risk mitigation is more important and practical measurement than fatality rate itself in the railway PRA For this reason, our risk measurement is supposed to become two dimensional. fatality rate and financial loss.

2)Risk weighting factors

Systematic analysis should be done for assigning weighting factors to railway risks and accidents that reflect better the subjective assessment of the severity/ importance of these event. Subjective importance of loss events differs according to their attributes. For example, a single accident that involves ten fatalities simultaneously will be much more severely perceived than ten separate fatalities.

3)Accident probabilities

Railway accident study in general has the difficulty to fully use probability theory as the means of inference about the probabilities of accidents. It is mainly because serious railway accidents are rare events and it is often not possible to find the statistical regularity of the events from that few data points available. Advanced statistical techniques which have been developed for making such inferences about rare events should be explored for their potential usefulness to the railway PRA.

International Rail Safety Conference

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9310

Dr. Friedel Mulke

A holistic approach to loss control in a Metro train service in South Africa

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

A HOLISTIC APPROACH TO LOSS CONTROL IN A METRO TRAIN SERVICE IN SOUTH AFRICA

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INTERNATIONAL RAILWAY SAFETY SEMINAR
ANGERS (FRANCE)

October 25 to 28 1993

A HOLISTIC APPROACH TO LOSS CONTROL IN A METRO TRAIN SERVICE IN SOUTH AFRICA

Presented by : Dr Friedel J Mülke
Spoornet (a division of Transnet Limited)
South Africa

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A HOLISTIC APPROACH TO LOSS CONTROL IN A METRO TRAIN SERVICE IN SOUTH AFRICA

by : Dr Friedel J Mülke
Spoornet (a division of Transnet Limited)
South Africa

1. Background

Commuter services are provided in the following Metropolitan Centres in South Africa namely Johannesburg, Pretoria, Cape Town, Durban, Port Elizabeth and East London.

In the two major centres viz. Johannesburg and Cape Town 410 000 and 470 000 daily passenger trips are respectively undertaken.

All the commuter rolling stock and most fixed assets in the Metropolitan Centres are owned by the South African Rail Commuter Corporation (SARCC).

The SARCC is government owned and 75 % of its operating budget is subsidized by the South African government. The SARCC has the mandate to see to the rendering of effective rail commuter services on a national basis in South Africa.

The operation of the commuter services and the maintenance of rolling stock are performed by Spoornet, the railway division of Transnet, on a contract basis to the SARCC. (See figure 1 in this regard.)

2. Accountability

The Machinery and Occupational Safety Act (Act 6 of 1983) governs all safety aspects in South Africa.

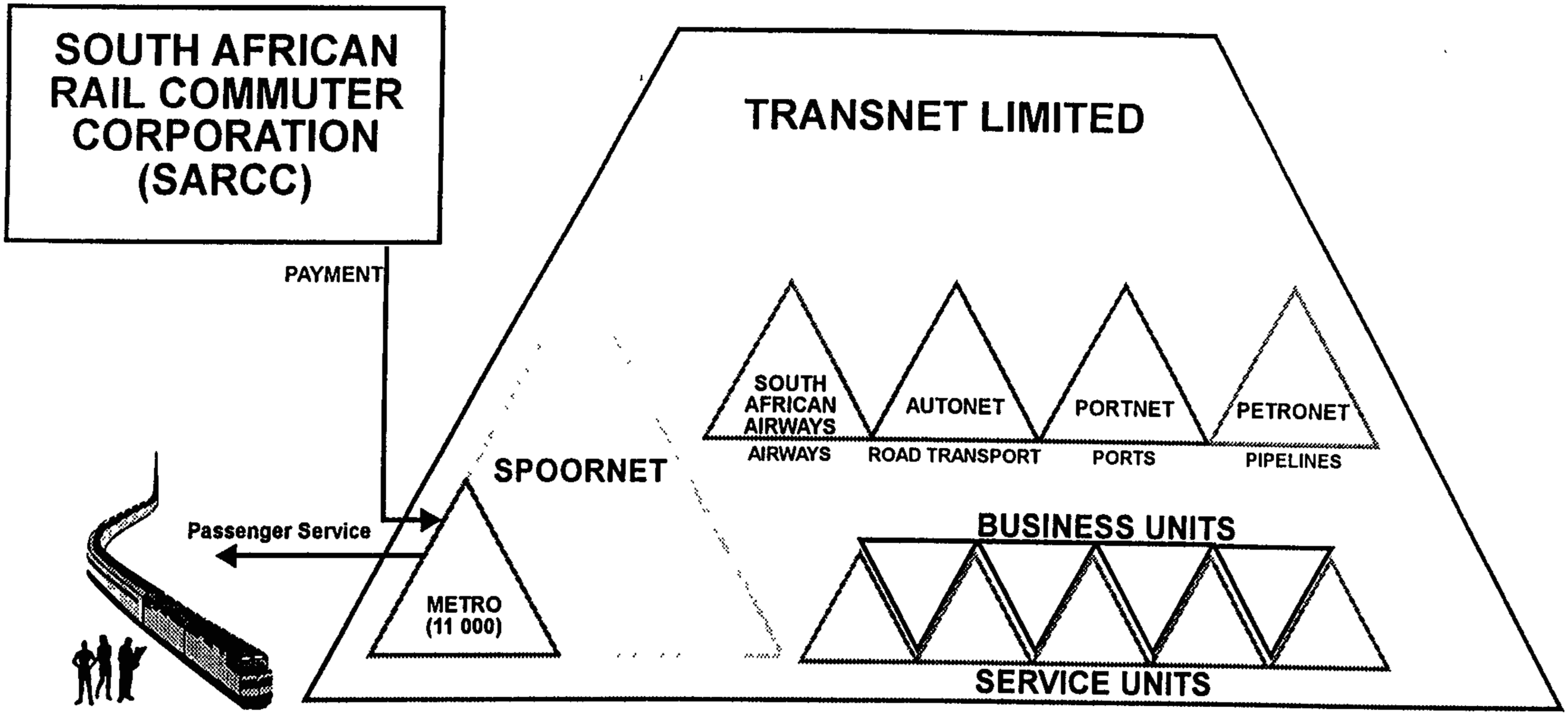
Due to the contractual relationship between Spoornet and the SARCC and the fact that Spoornet is the renowned and experienced railway operator in South Africa, the accountability of rendering a safe passenger service vests totally in Spoornet.

Accountability and responsibility arising from the contractual performance obligations has necessitated the introduction of safety programmes and the auditing of existing safety related systems and methods.

In 1993, an increase in the incidence of cracked tyres on commuter rolling stock gave indications of safety risks to passengers and resulted in concerted efforts of Spoornet Management to address the risk issue. (See figure 2 for Cape Town.)

Figure 1

FUNCTIONAL DIAGRAM OF RENDERING OF THE METRO PASSENGER SERVICE IN SOUTH AFRICA



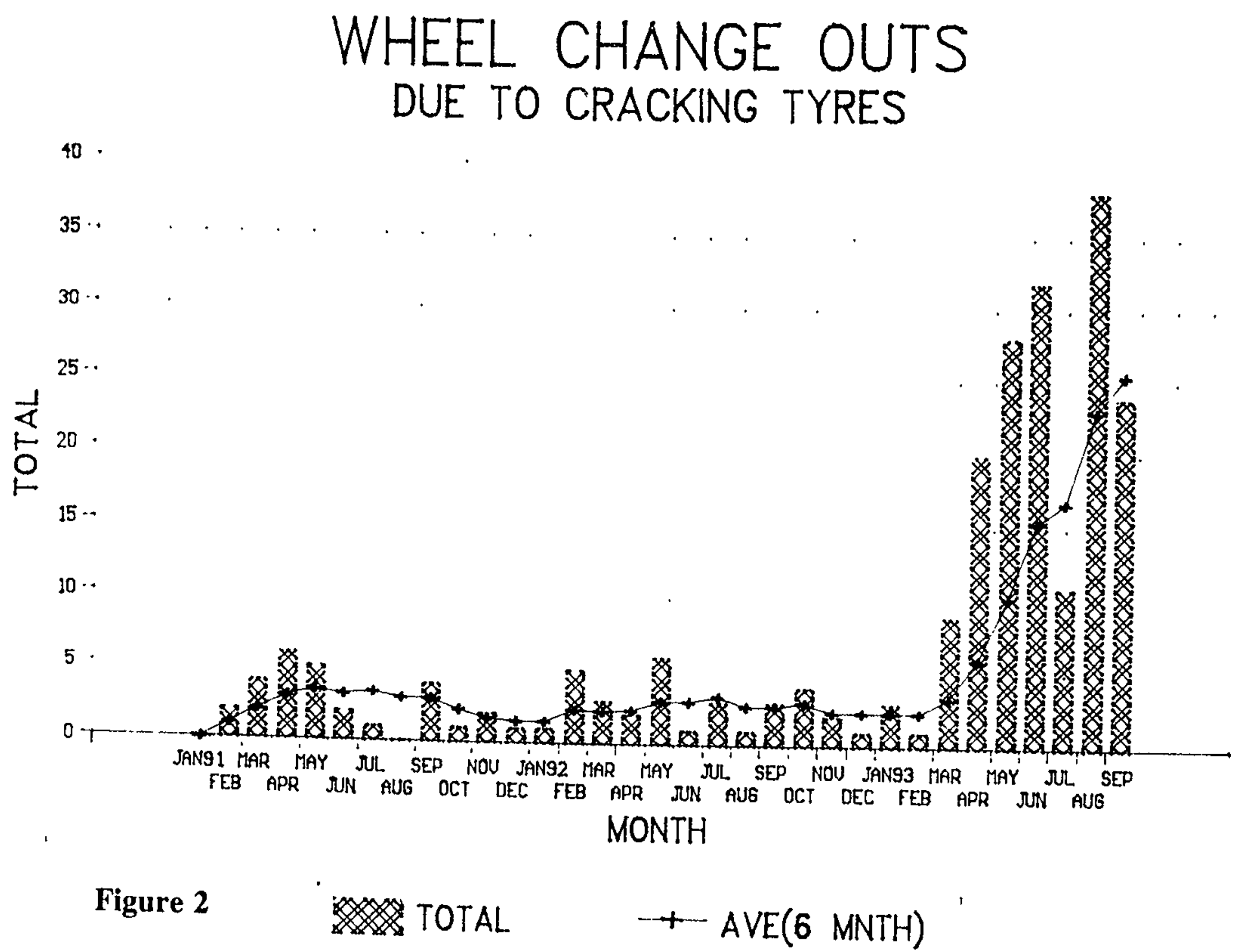

WHEEL CHANGE OUTS
DUE TO CRACKING TYRES
TOTAL
0
5
10
15
20
25
30
35
40
JAN91 FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN92 FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN93 FEB MAR APR MAY JUN JUL AUG SEP
MONTH
TOTAL
AVE(6 MNTH)

Figure 2

3. Cracked wheel tyre incidents on Metro trains

During the first quarter of 1993 a rising rate in the incidents of Metro train derailments in two major Metropolitan areas due to cracked wheel tyres, resulted in the in depth investigation into the cause of the cracked tyres.

As a first measure to prevent Metro trains from being operated with advanced crack formation in wheel tyres, the frequency of both off-pit and pit inspections was increased.

Each Metro trainset was to be inspected at least once per week. Every second week this inspection took place on Metro Train Depot pit roads and maintenance practices and procedures were strictly applied.

Transnet, as the contractor to the South African Commuter Corporation, took full responsibility for the preventative maintenance of Metro train sets and cracked wheel tyres as such.

The decision was taken by Metro to have :

(i) an investigation launched to determine the cause of the increase in the incidence of cracked wheel tyres on specific routes in South Africa; and

(ii) to audit the maintenance and incident prevention policies, practices and procedures at Metro maintenance depots.

The following overview is given regarding the general approach to crack formation in wheel tyres.

4. Overview regarding crack formation in wheel tyres

There are two main schools of thought with respect to the mechanism of thermal fatigue cracking and several researchers have tried to explain their results by using either of the Martensite theory or the Restrained Expansion or Van Swaaij theory.

4.1 Martensite theory :

Wheels and tyres are braked under conditions which locally raise the temperature on the tread into the austenitizing range. Upon cooling, the hot spot transforms to Martensite which involves a volume expansion.

The ability to form Martensite is governed by the steel hardening ability ie. alloy content and the hardness of the Martensite is governed by the Carbon content of the Steel. As the hardness increases, so does the brittleness of the steel.

Figure 3

4.2 Restrained Expansion/Van Swaaij theory :

Van Swaaij put forward a suggestion that hot spots on the tread undergo repeated and therefore stress cycles that may cause cracking independently from the formation of Martensite.

Van Swaaij found it difficult to explain certain observed phenomena by using the Martensite theory. These phenomena include that it often takes more than 15 000 km of service before cracking occurs and that cracking often occurs on the outer plane of the tread where there is no brake contact. (See figure 3 in this regard.) Therefore Van Swaaij developed the theory of restrained expansion which was used by researchers world wide in their approach to crack formation.

4.3 Carbon content in wheel tyre.

The Researchers concluded that the resistance to thermal cracking in wheel tyres increased by using materials with as low a yield stress as operating conditions would allow and by restricting the Carbon content.

It was also found that the desired tensile and yield strength could be achieved at lower Carbon contents with improved ductility by using a quench and temper heat treatment instead of a normalising treatment.

The following general recommendations were made by Metro researchers at an early stage of the investigation :

(i) Steels with the lowest strengths compatible with axle loads and wear resistance should be used;

(ii) steels with as low as possible Carbon contents should be used in tyres; and

(iii) rim quenching should be used as the preferred heat treatment, especially for wheels.

4.4 The Fracture toughness :

The approach of determining fracture toughness (KIC) of steel wheels was

The probability and simulation calculations available to determine critical cra were not sufficiently accurate to determine the service limits of permissibl depths.

The accompanying volume expansion resulted in the generation of tensile stresses and eventually the cracking of the wheel tyres.

5. **Results of studies**

Results of studies undertaken on the cracked tyres on Metro trains (see figure 4) indicate that increased stresses can be accommodated with increasing KIC for certain crack depths.

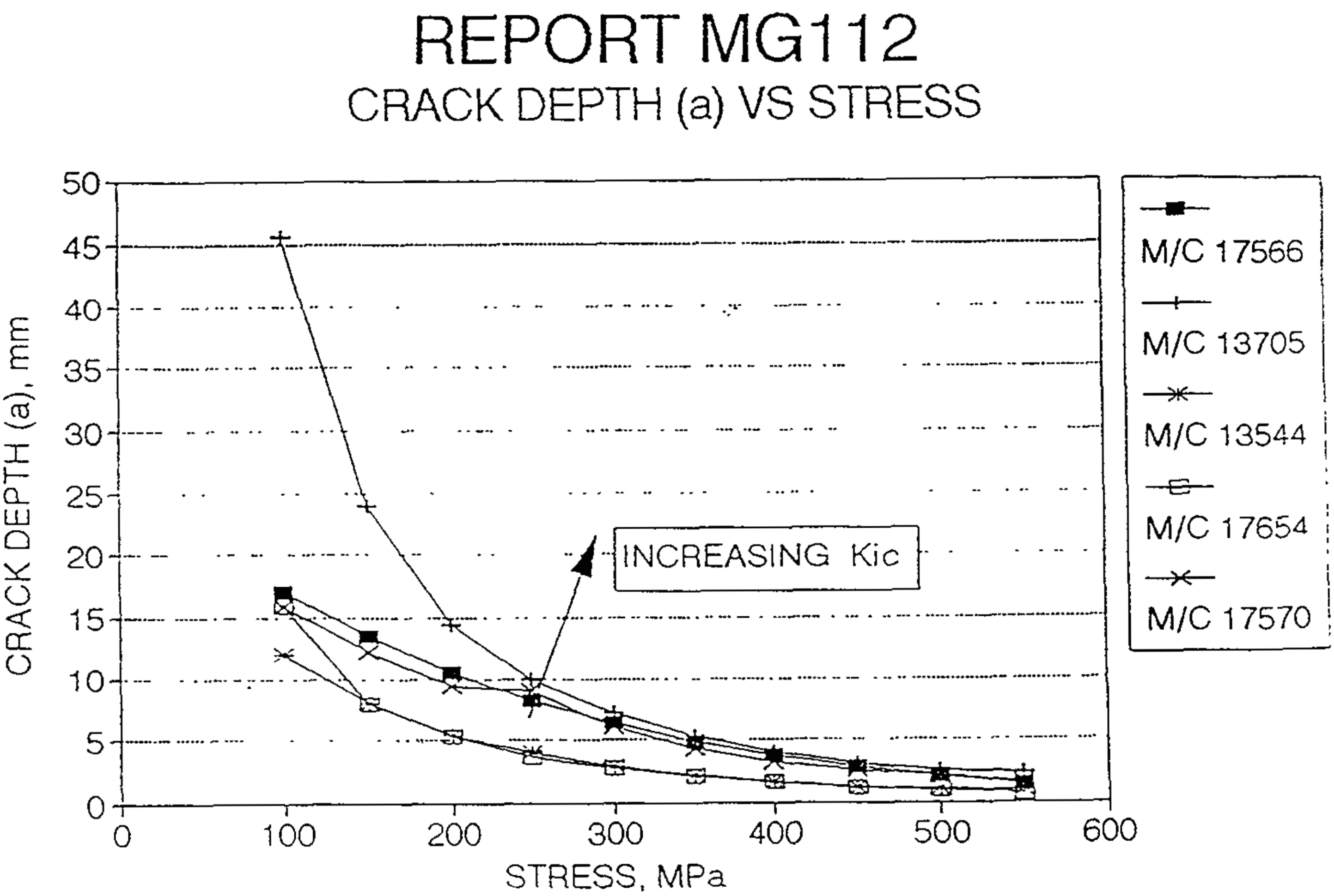


Figure 4 : Crack depth versus working stress with increasing KIC.

From an operational safety point of view the increase in crack size as a result of drag braking applications was of utmost importance and led to further investigations by the Metro researchers in that regard.

The brake application patterns on Metro train sets for the different sections in South Africa were investigated and correlated with the rate of incidents of cracked tyres on the train sets in service on the specific routes.

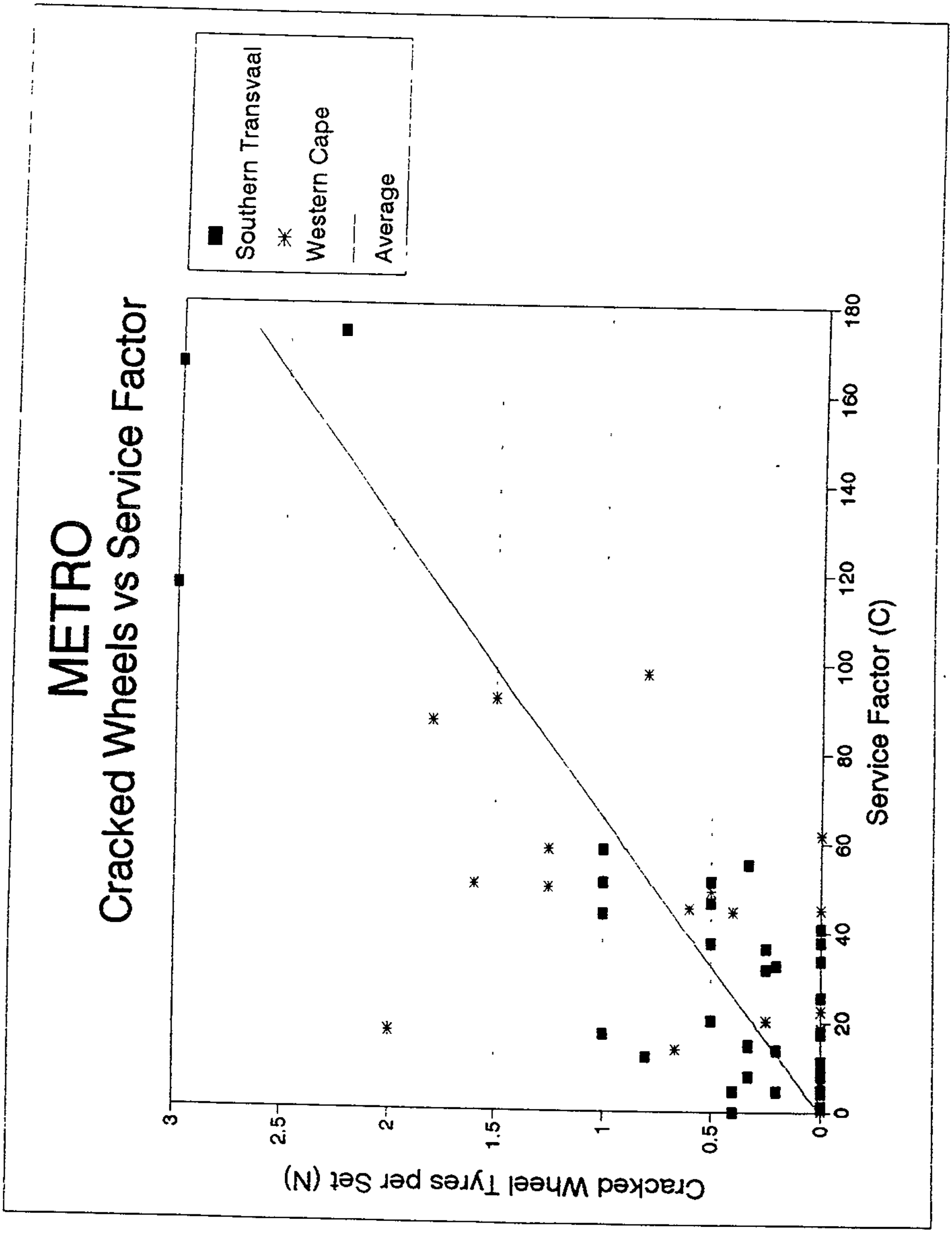

METRO
Cracked Wheels vs Service Factor
Southern Transvaal
Western Cape
Average
Cracked Wheel Tyres per Set (N)
Service Factor (C)
0
0.5
1
1.5
2
2.5
3
0
20
40
60
80
100
120
140
160
180

Figure 5

The results in figure 5 were plotted as the number of cracked wheel tyres per set (N) in relation to a Service factor (C).

The Service factor is empirically expressed in terms of the Kinetic Energy applied by the braking system to the wheels over a period of time.

The Kinetic Energy is transformed into heat energy in the wheel and is directly proportional to :

V^2; where V is the mean speed maintained over a section of line (Km/h).

A; where A is the number of stops per week.

and inversely proportional to :

L; where L is the distance between stations or stops.

and $$C = \frac{V^2 A}{L}$$

The number of cracked tyres per set (N) is therefore directly proportional to C :

$$N \alpha C$$

The results in figure 5 indicate that on sections of lines with stations spaced on short intervals, resulting in a high frequency of brake application, the Service factor (C) exceeded the value of 110 and three cracked wheel tyres per set occured.

6. Service factor application for control purposes

6.1 A limiting service factor value for control purposes was taken as 80 for the specific lines.

A prescribed slower mean speed of the train set (V) could only be achieved by :

- altering the time table for the Metro Service on such lines;
- or the bypassing of stations;
- or changes in the handling of the train set concerning drag brake application.

Although the mean speed between stations was decreased (see figure 6), it was found that the rate of brake application played a major role in temperature ranges in wheels.

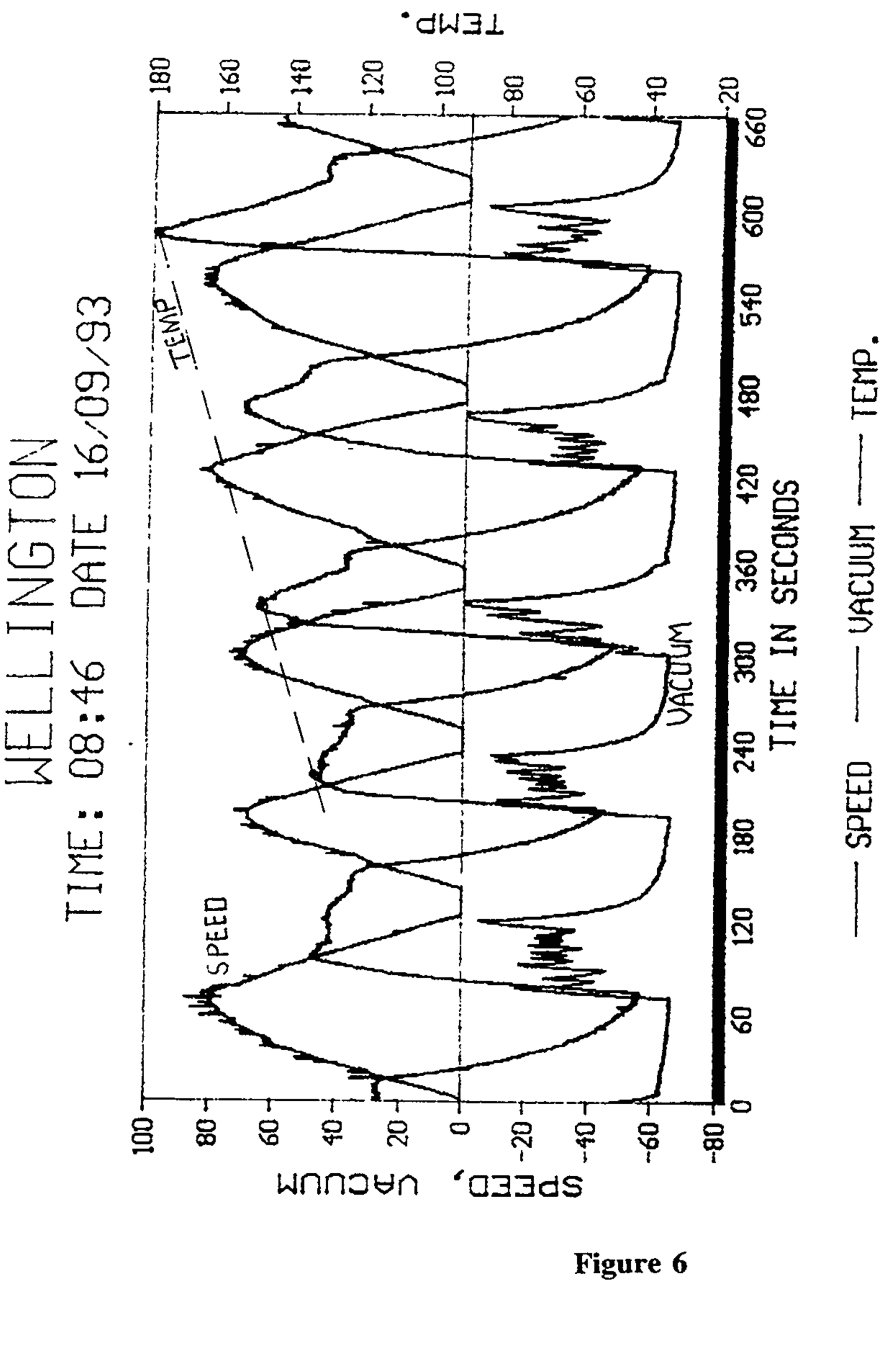

WELLINGTON
TIME: 08:46 DATE 16/09/93
SPEED
VACUUM
TEMP
TIME IN SECONDS
0 60 120 180 240 300 360 420 480 540 600 660
SPEED, VACUUM
100 80 60 40 20 0 -20 -40 -60 -80
TEMP.
180 160 140 120 100 80 60 40 20
SPEED —— VACUUM —— TEMP.

Figure 6

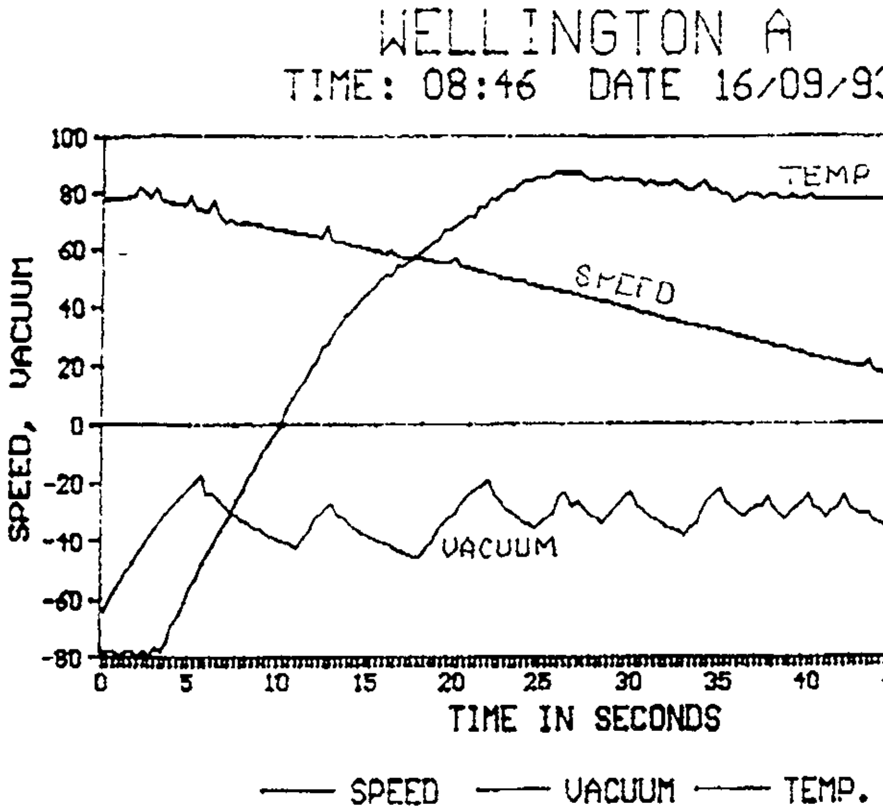


Figure 7

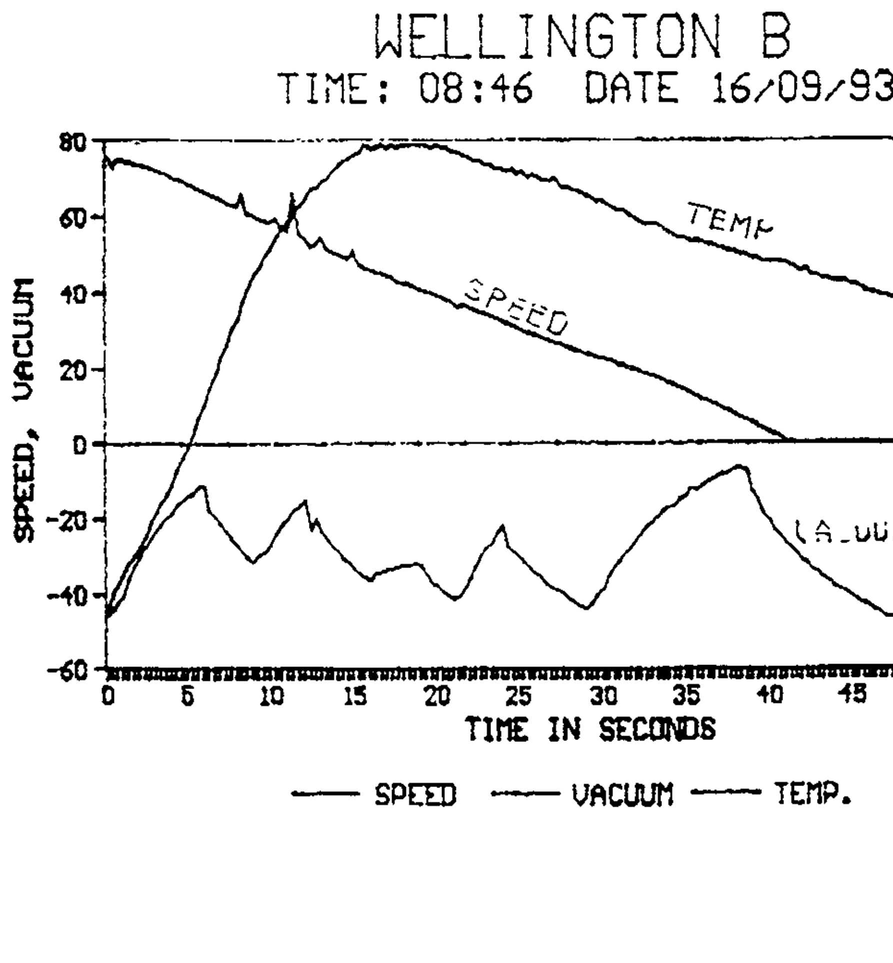


Figure 8

6.2 The effect of drag brake application.

The increase in temperature in wheels due to drag brake application was found to be the most important factor contributing to cracked tyres.

The results of temperature readings of wheels of a prolonged brake application in figure 7 compared to the results of temperature readings in figure 8, show an increase from 130°C to 180°C for an increase in brake application intensity over an incrimentally shortened period of 10 seconds.

7. Conclusion : Results

The measurement of results, taking various factors on lines as well as train handling by drivers into account, is still underway on the Metro system in South Africa.

The most significant external contributing factors were found to be :

(i) the intensity of drag brake application by train drivers maintaining too high speeds into stations;

(ii) the frequency of train stops subjected to the handling in (i) above; and

(iii) the distance between stops prohibiting the cooling of wheels between stops in conjunction with the intensity of brake application into station areas.

These factors were taken into account with the safety audit performed on the specific project in Cape Town.

8. From audit to management goals

8.1 The Safety audit :

The train set safety management system with special emphasis on the management of wheel tyre cracks, was given serious consideration by the Management of the Metro division and a decision was taken in the last quarter of 1993 to audit the actions taken on the cracked wheel tyre incidents.

The holistic approach in terms of the ILCI auditing system was regarded as the best means to cover the whole spectrum of research, information gathering, deployment of programmes and monitoring systems put into place to address the problem.

The ILCI audit was concentrated on the Cape Town Metro system.

The process followed is shown in figures 9 and 10.

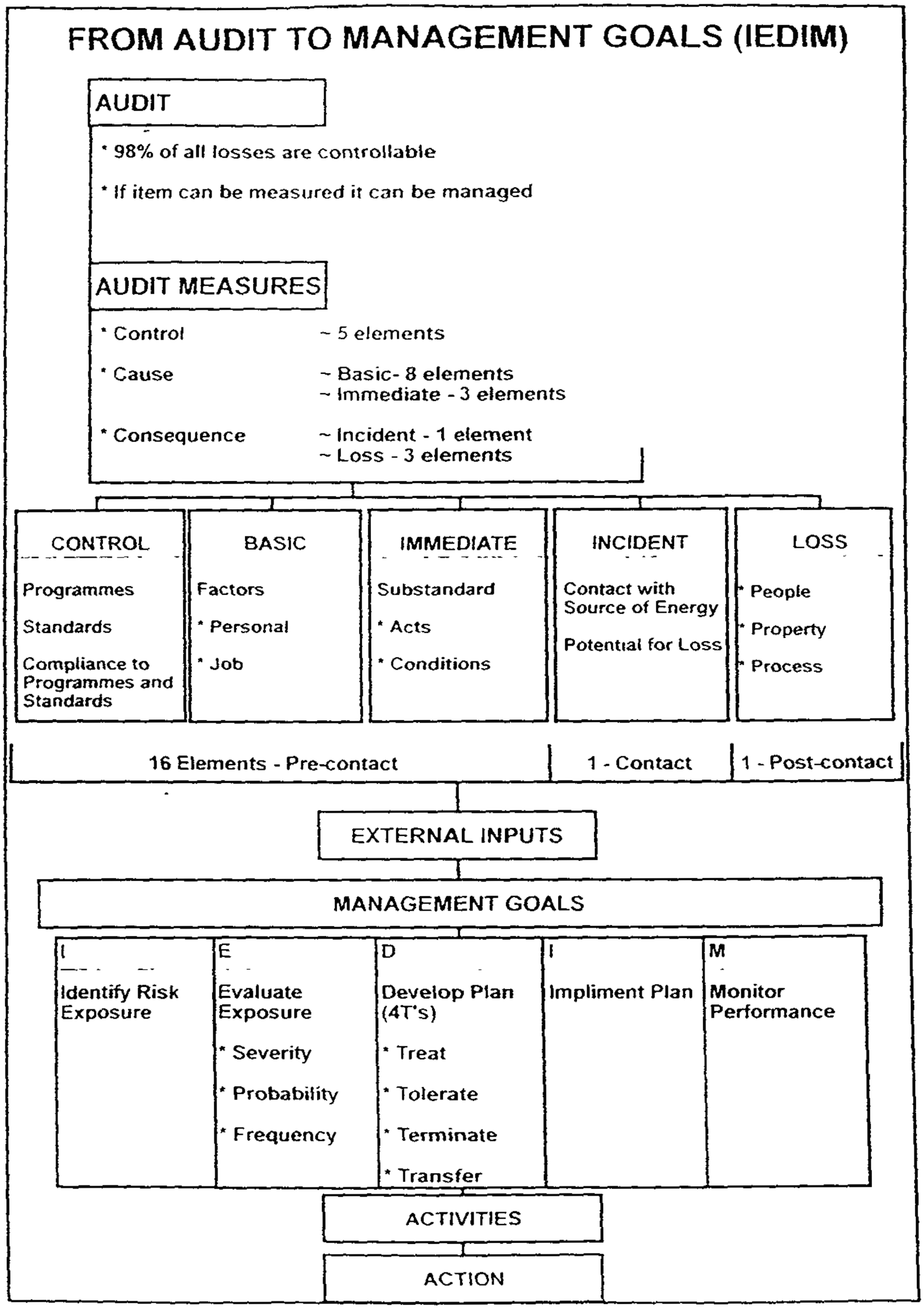

FROM AUDIT TO MANAGEMENT GOALS (IEDIM)
AUDIT
* 98% of all losses are controllable
* If item can be measured it can be managed
AUDIT MEASURES
* Control ~ 5 elements
* Cause ~ Basic- 8 elements
~ Immediate - 3 elements
* Consequence ~ Incident - 1 element
~ Loss - 3 elements
CONTROL
Programmes
Standards
Compliance to Programmes and Standards
BASIC
Factors
* Personal
* Job
IMMEDIATE
Substandard
* Acts
* Conditions
INCIDENT
Contact with Source of Energy
Potential for Loss
LOSS
* People
* Property
* Process
16 Elements - Pre-contact
1 - Contact
1 - Post-contact
EXTERNAL INPUTS
MANAGEMENT GOALS
I
Identify Risk Exposure
E
Evaluate Exposure
* Severity
* Probability
* Frequency
D
Develop Plan (4T's)
* Treat
* Tolerate
* Terminate
* Transfer
I
Impliment Plan
M
Monitor Performance
ACTIVITIES
ACTION

Figure 9

FROM AUDIT TO ACTION (ISMEC)

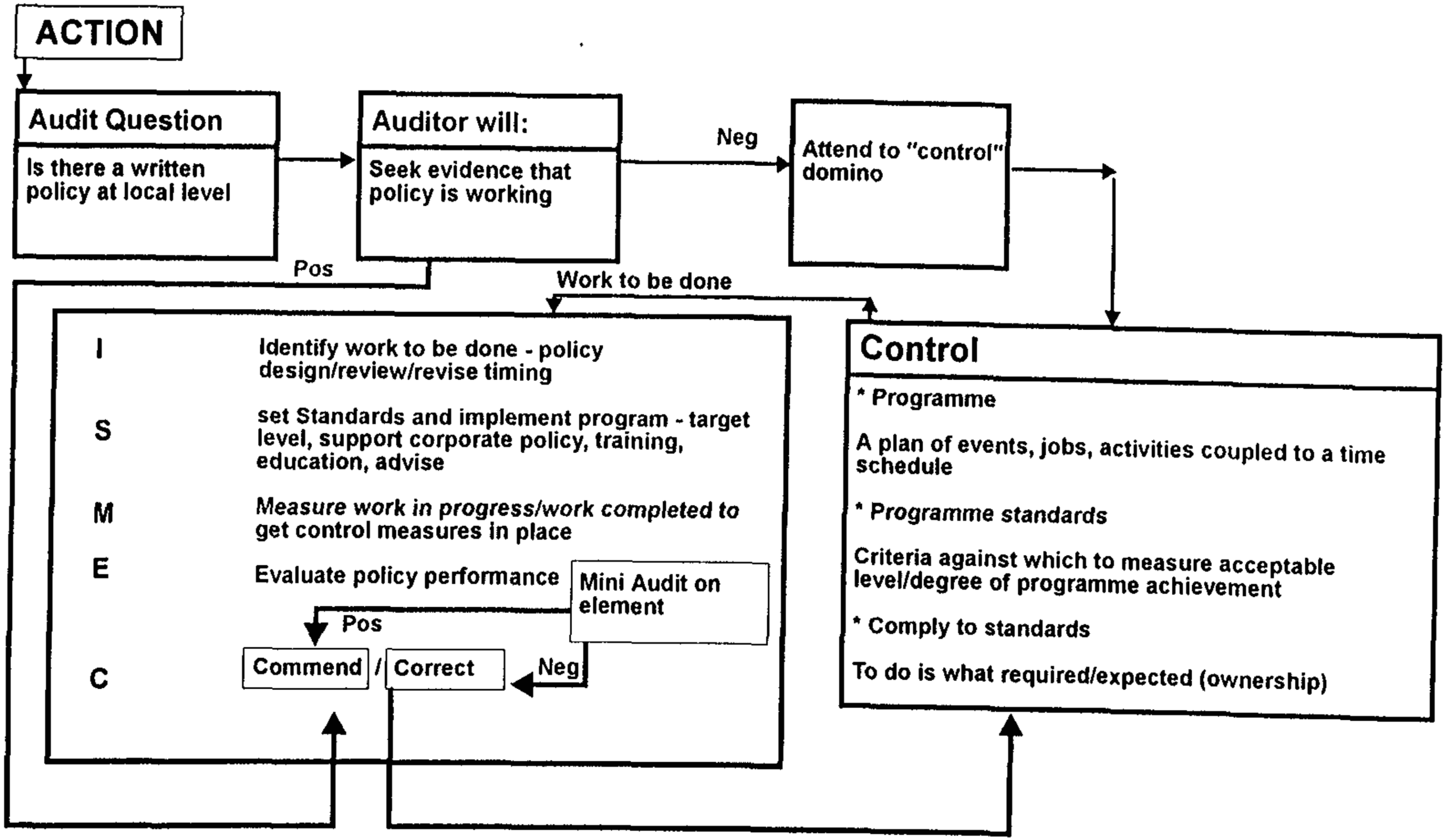


Figure 10

The first step was to perform an audit on the terrain of :

(a) - Control of the aspects;
(b) Causes of the incidents; and
(c) Consequences of the incidents.

The Control terrain is spread over the functions of :

(i) Direct Control Measurements.

(ii) Basic causes or factors leading to the incident; and

(iii) Immediate causes of the incidents relating to :
  (a) Acts performed by personnel;
  (b) Working conditions leading to the incidents.

The failing of control measures on the functional area in (i), (ii) and (iii) above will invariably lead to the occurrence of the incident and the resultant losses.

The Cause terrain is covered by measuring elements leading to basic causes, namely the capabilities of personnel and the physical job safety situation.

The auditing of immediate causes leading to incidents and losses are covered in the areas of substandard activities and substandard factors in the environment giving rise to incidents.

The terrain of consequences comprises incidental factors and the kerbing of losses to a minimum level.

Having measured the aforementioned terrain of control, the terrain of expectancies put by Management is audited.

8.2 Deriving management goals.

Management's goals in minimizing losses and introducing control measures are audited and tested against the Scenario of :

(i) Identifying risk exposure.

(ii) Evaluating the exposure.

(iii) Development of plans to :
  (a) Treat the problem;
  (b) Tolerate the problem;
  (c) Terminate the function;
  (d) Transfer the aspects.

(iv) Implementation of management plans;

(v) The Monitoring of the performance concerning the programme.

Most of the steps from programmes (i) to (v) can be derived from the preceding audit.

The action plans follow from the auditing of functions and terrains and the auditor will seek evidence that Management policies and programmes are effective.

The Control "domino" (see figure 10) will be addressed in terms of :

(i) The presence of a programme;

- A plan of events, job activities completed to a time schedule.

(ii) The qualification of programme standards;

- the criteria against which to measure the acceptable level/degree of programme achievement.

(iii) The compliance to standards;

- the execution of what is required and expected by "owners" of the programme.

If the audit of the Control domino indicates that work has to be done to developed the terrains (i) to (iii) in this field, the audit is expanded to cover the following :

(a) Identification of work to be done;

- seek evidence of policy design, reviews/revision of time scales.

(b) Setting of standards and the implementation of programmes;

- seek evidence of target levels support of corporate policy, training programmes, education and advisory systems.

(c) Measuring of work in progress;

- seek evidence of work done to get control measures in place.

(d) Evaluation of policy performance is performed and a mini audit is performed in this regard. If the result is positive, the programme is commended. If the result is negative, corrections are applied and the Control domino is readdressed in a new audit loop.

9. The holistic approach

In this paper, the author endeavoured to indicate that segments of activities in a railway commuter system can be focused with a safety audit.

The macro environment determines the accountability in an operational system.

Management is responsible to interpret the accountability and manage the information leading to the determining of critical safety and success factors and programmes.

These programmes have to be mobilized on depot and functional levels and the success rate monitored.

The generating of programmes and enthusing of personnel are some of the major input areas of management and was specifically audited in Cape Town.

However, the holistic approach of determining the causative factors of wheel tyre cracks on Metro train sets and the auditing of the project, focused the attention and energies of all concerned in the project.

The ILCI-safety audit in Cape Town created a basis for goal formulation in 1993 and will be audited on a regular basis in future.

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International Rail Safety Conference

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9311

Jan Hendricks

Risk analysis method RAM

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

RISK ANALYSIS METHOD

ON NETHERLANDS RAILWAYS

Joss HENDRIKS

Head Railway Safety Department
Operations Division
NV Nederlandse Spoorwegen

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1. INTRODUCTION

2. WHAT IS RISK?

3. THE INCIDENT

4. THE CAUSES AND CONSEQUENCES OF INCIDENTS

5. THE RISK ANALYSIS MODEL

6. COUNTERMEASURES

7. DETERMINING THE EXTENT OF THE RISK

8. CHECK-LIST

Ep 4.1
Netherlands Railways
August 1993 version

1. INTRODUCTION

In specifying activities for the Railway Safety Annual Programme it is important to know what effect these actions (can) have on the level of Railway Safety. Carrying out a risk analysis can often help. With the analysis causes of (possible) incidents and accidents are brought to light, risks are quantified and the effects of countermeasures revealed. This memorandum explains the method developed by the Safety Department of the Operations Division, in collaboration with the Consultass bureau. The method is in use as practical loss causation model for Risk Analysis and accident/incident investigation. The method is unsuitable for the evaluation of extreme risks. Risk analysis is used to assess existing risk, future risks (new infrastructure) and to specify requirements for new systems like Automatic Train Protection ATP.

2. WHAT IS RISK?

The term risk is defined differently by many people. In the opinion of many the extent of a risk is determined mainly by the chance that something can go wrong. Others think about causes and yet others about the consequences. If the chance of a certain event is very small, people generally consider the risk to be not so great.

The **CHANCE** is clearly an important element in estimating risks. Here it is not a question of one single chance, several chances are possible:

1. the chance OF something going wrong (practicality chance);
2. the chance of particular consequences (the extent chance).

The consequences themselves are also risk-determining. In fact, determining a risk means acquiring knowledge of the accident scenario. Here the following questions must be answered:

1. Which activity/risk-location is examined?
2. What can go wrong here? [potential incident(s)]
3. What is the chance of this incident?
4. What are the possible consequences?
5. What is the chance of different consequences/possibilities?

Estimating chances and consequences will be different for each person. Therefore, in determining the risk a personal assessment will always play a part. With the developed Consultass method the discussion about risks can be more easily conducted and therefore an assessment acceptable to all involved can be reached.

3. THE INCIDENT

Any job or activity is accompanied by the risk of accident. The characteristic feature of an accident is that something has gone wrong; an undesired event therefore. Undesired events which can go hand in hand with human injury, material damage or interference with the process. With hindsight, these events are often easy to recognise. Recognising such events in advance is much more complicated. Precisely because so many kinds of undesired events can take place. These undesired events are called **incidents** and **accidents**. These terms are defined as follows:

Incident

Undesired event, which influences or can influence the quality of the transport process, and which could lead to losses.

Accident

Undesired event, which leads to loss.

In the Consultass method the term incident is also applied in the case of an accident. In the NS the term irregularities is often also used for this.

In order to achieve satisfactory accident prevention it is important to recognise incidents which may possibly occur during the carrying out of certain activities and to prevent them by taking countermeasures. It is necessary to determine in a very concrete manner for what incident we wish to take such measures. The nature of the incident in fact determines directly the manner of prevention. Depending on the nature of the activities various incidents may take place. To be able to manage the risks it is necessary first of all to determine what **activity** or **risk-location** is involved and what **incident** or incidents can therefore occur. In other words:

WHAT CAN GO WRONG?

Here it is important to examine the various possible incidents. Often people concentrate on the (apparently) most important incident and other possibilities are (too) quickly ignored.

If the incidents which can occur during a particular job or a particular operation are known, then the (relevant) underlying causes must be traced. With this we gain an insight into the chance of occurrence and the possibilities of prevention. The chance of the particular incident occurring can thereby be reduced.

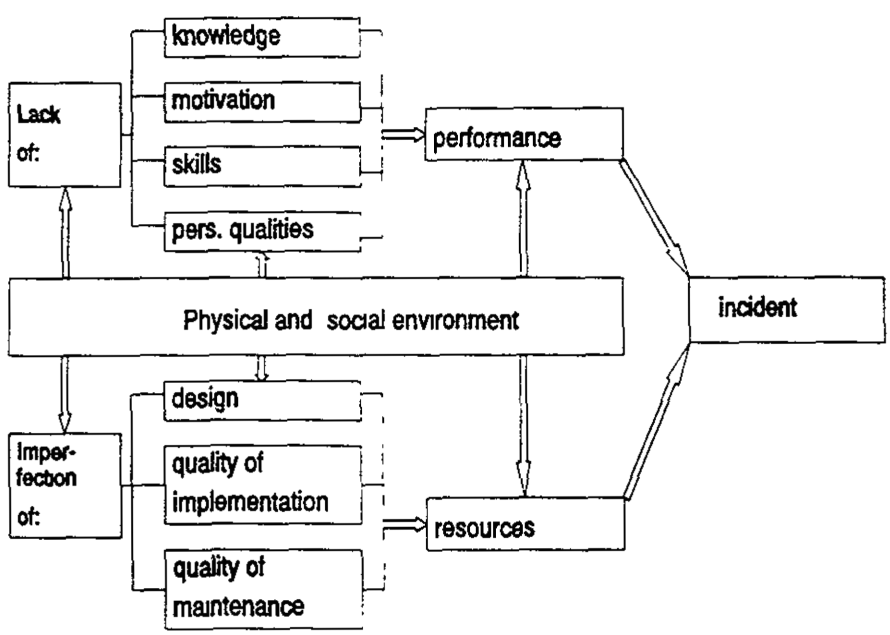
4. THE CAUSES AND CONSEQUEN ES OF CIDENTS

4.1 Causes of incidents

In determining causes of incidents there is usually a correlation with:
a. the manner in which the work is carried out, the PERFORMANCE.
b. the materials and tools used for the work, the RESOURCES.
c. events and circumstances surrounding the workplace, the ENVIRONMENT.

PERFORMANCE, RESOURCES and ENVIRONMENT are called the primary or basic causes of incidents; but in order to recognise risks and ultimately to be able to manage them attention must not only be paid to the basic causes. They are in fact in turn the consequence of underlying causes. Thus acting in an unsafe manner can be caused by lack of knowledge or awareness and unreliable equipment or incorrect materials. In regard to the definition ENVIRONMENT we must think of two aspects:

1. the PHYSICAL ENVIRONMENT, for example poor lighting, excessive noise, heat, cold, etc.;
2. the SOCIAL ENVIRONMENT, for example distraction by colleagues, the situation at home, visitors to the workplace, relations with the superior, pressure of work, preparation of the work, etc.



CAUSES OF INCIDENTS

4.2 Consequences of incidents

The same incident can have several consequences or **losses**. Among these we can identify:
- injury to passengers, third parties or our own personnel;
- damage to transported goods;
- damage to the environment or the railway surroundings;
- damage to resources;
- irregularities in the transport process;
- damage to the NS image or reduction in turnover.

When taking measures intended to promote safety at work, we (too) often see people taking action when a serious accident has occurred. It seems that incidents often proceed "satisfactorily". The failure of people or machines is usually not directly punished in the form of visible losses. This type of incident however is of importance for finding the causes of the few incidents which have serious consequences. The relationship can be visualized by a so-called "Safety Iceberg". Very many unsafe operations may have taken place before an accident occurs. By reducing the number of unsafe situations and actions the number of incidents with "serious" consequences can be reduced. The figures in the "Safety Iceberg" are not absolute, but indicate the order of magnitude.

5. THE RISK ANALYSIS MODEL

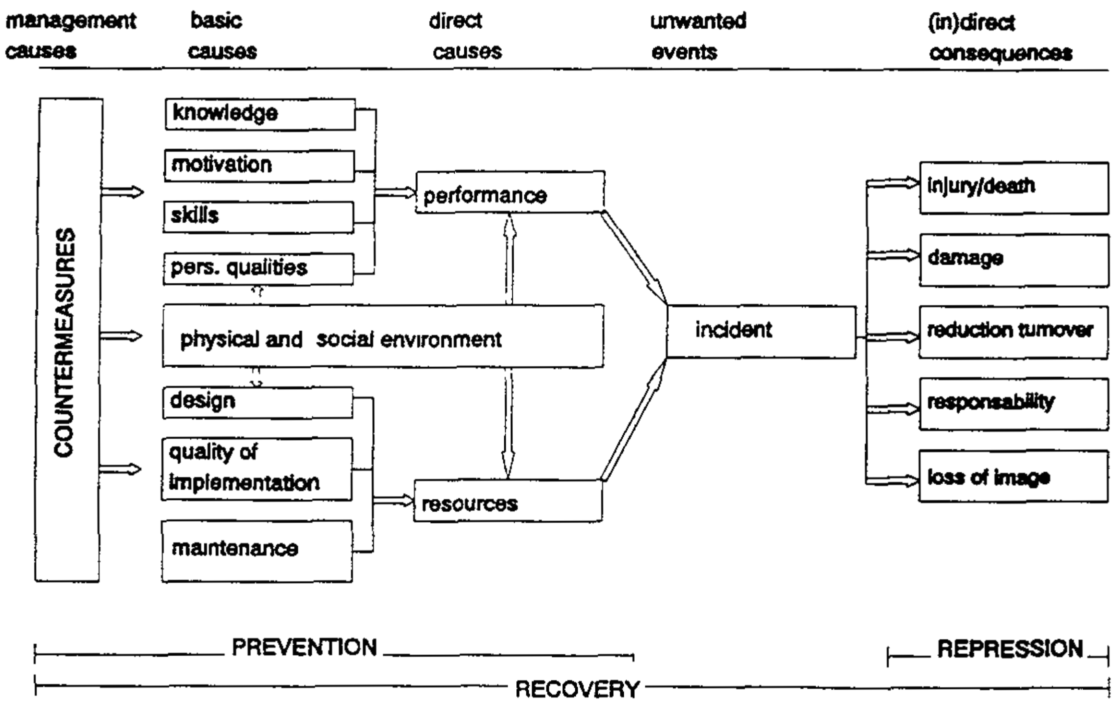
From the above it is clear that the expression "risk" consists of a number of elements, in which the following are central:

CAUSES --> INCIDENTS --> CONSEQUENCES

Among the causes we can distinguish between the **direct (immediate) causes** and the **basic (underlying) causes**. Among the consequences we have seen that it is not always necessary for things to go wrong and that it is often a matter of "luck". This is indicated by the "Safety Iceberg".

Specifying the various incidents which can occur during work is one of the most important steps in arriving at effective risk management. The central question here is: "What can go wrong?". Here one should not come too rapidly to the conclusion that something is impossible: history teaches us - alas - that the accidents which were considered impossible still took place!

The risk analysis model shown below reproduces the above scheme. When an incident is defined, with the help of a model it is possible to investigate what the causes are (can be) and whether countermeasures should be considered which could possibly prevent the incident. In the following section the countermeasures will be discussed. The model serves as a guide to seeing which factors can be improved. After that the model can serve as a "tool" for setting up structured accident investigation.



Risk Analysis Model RAM

6. MEASURES

If an accident has taken place and people proceed to investigate it, then (too) often the emphasis is placed on mistakes of the persons directly concerned. From the risk analysis model it also appears that incidents do not just fall out of the sky: incidents are usually the result of factors of influence for which ultimately the management bears responsibility. The management must ensure that technical and organizational measures are taken whereby the chance of incidents is minimised. Naturally people carrying out work must then apply the measures adopted in the correct manner.

There are 4 kinds of measures for reducing risks:

1. avoiding the risk in question, **source elimination**;
2. preventing accidents and incidents by technical measures, **prevention**;
3. limiting the occurrence of accidents and incidents by rules and instruction, if necessary in combination with technical measures, **correction**;
4. restricting as far as possible the damage resulting from accidents and incidents by rules, instructions, insurance, etc., together with technical measures, **damage limitation.**

In managing the safety risks the priorities of source elimination, prevention, correction and damage limitation must always be maintained. Here there must be a reasonable balance between all the efforts in the safety field. The desired level of safety must not be by definition the maximum possible at any price either.

7. DETERMINING THE EXTENT OF THE RISK

An important aid in determining the measures to be carried out or standards to be set is the risk analysis. The described Risk Analysis Method is to be applied to comparing "average" risks. The method is unsuitable for the evaluation of extreme risks, in other words risks with very small chance of very major consequences. The starting point of the Consultass method is that a risk is built up of the components <u>chance</u> and <u>effect</u> (consequences) in accordance with the equation

RISK = CHANCE x EFFECT (R = C x E)

The method consists of 10 steps:

Step 1, determining activity/risk location

During which activity or at which location is there the possibility of risk.

Step 2, determining what can go wrong

What incident can occur during the activity to be contemplated.

Step 3, determining the chance

The chances of the incident occurring are assessed by a numerical value 1 (= very small chance) to 5 (= large chance). The following table serves as a guide.

the chance of an incident (C)		
CHANCE	FAIL FREQUENCY	VALUATION
very small chance	> 10 years	1
small chance	2 - 10 years	2
average chance	½ - 2 years	3
fair chance	1 - 6 months	4
large chance	< 1 month	5

Step 4, determining consequences

The most probable consequences are determined. Here we consider damage, injury, turnover loss, image loss, process losses, etc.

Step 5, estimating effects

A figure for the effects is allocated to the most probable consequences determined in step 4. The figure 1 for very minor consequences, the figure 10 for very serious consequences. With the help of the table below the figure for the effects can be determined.

the possible consequences/effects (E)			
1 2 3	4 5 6	7 8 9	10
accident with slight injury/insignificant damage (until Fl 10.000)	accident with serious injury and/or damage (Fl 10.000 - 300.000)	invalidity / very large damage (Fl 300.000 - 1.000.000)	death / major loss (> Fl 1.000.000)

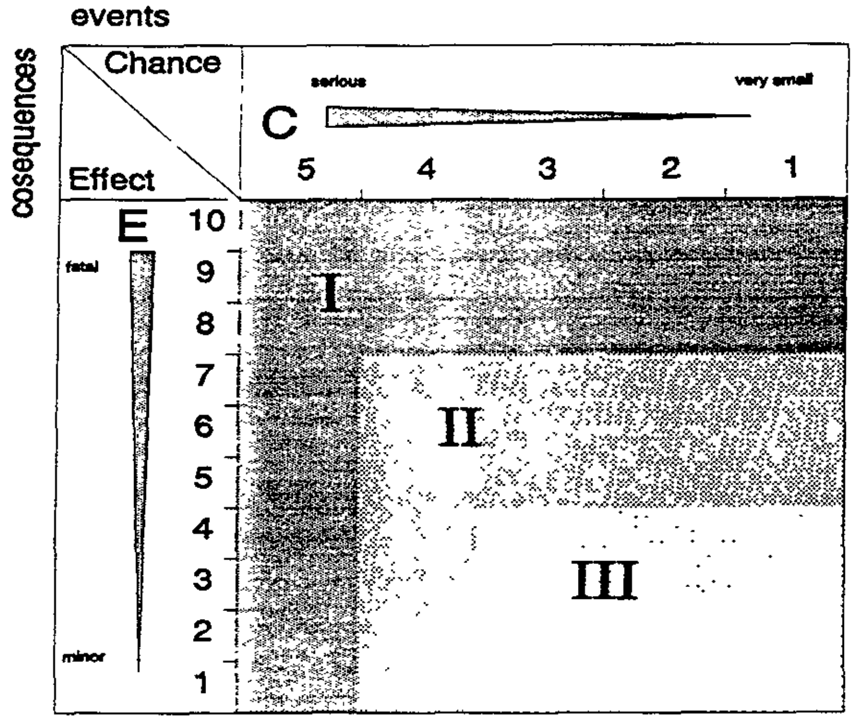
Step 6, determining risk (R = C x E)

The extent of the risk (R) is determined by multiplying the chance (C) by the effects (E).

Step 7, determining what standard the risk must satisfy
With the values found for R, C and E we determine in what risk class the risk is located.

Risk value	Priority	Time-limit measures
C > 4 and/or E > 7	Class I	acute
C > 3 and/or E > 4	Class II	within 1 month
C ≤ 3 and/or E ≤ 4	Class III	within 1 year/ needs attention

Risk classes, reproduced graphically:



Step 8, countermeasures

In this step we determine what countermeasures are possible for limiting the risk. Here the priority sequence is applied (source elimination, prevention, correction, damage limitation).

Step 9, determining risk reduction

For each countermeasure and for the sum of countermeasures we determine what the risk reduction shall be. If the risk after the countermeasures is R1 (= K1 x E1) the risk reduction is {(R - R1)/R} x 100%.

Step 10, cost-benefit analysis

As the last step a cost-benefit analysis is made for each countermeasure or for the sum of countermeasures. After that the responsible management can make a choice.

8. CHECK-LIST

The check-list can be a handy tool to walk through the 10 step Risk Analysis Method.

Step	Question	Answer
1	Which activity/risk location?	
2	What can go wrong?	
3	What chance is there of such an incident taking place? 1 = very small chance 2 = small chance 3 = average chance 4 = fair chance 5 = large chance	C =
4	What would be the consequences of such an incident taking place? At best: At worst: most probably:	
5	How severe do you estimate these most probable consequences to be? 1 ——————> 10 moderate very severe	E =
6	R = C x E	R =
7	What criterion must the risk satisfy?	
8	Which measures are feasible (in addition) to limit the risk? 1. Source elimination 2. Prevention 3 Correction 4. Damage limitation	
9	To what degree is the risk reduced by each measure? R1 = C1 x E1 Risk reduction: {(R - R1)/R} x 100%	
10	Cost-benefit analysis per measure or combination of measures? Conclusion/recommendation:	

International Rail Safety Conference

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9312

Jan Stuifmeel

Injuries sustained by passengers due to the malfunctioning of the outer doors of train

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

INJURIES SUSTAINED BY PASSENGERS DUE TO THE MALFUNCTIONNING OF THE OUTER DOORS OF TRAIN

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1. INTRODUCTION

1.1 Departure procedures

The two main methods employed by NS to make passenger trains depart a railway station are:
A. issuing the departure command by means of a "green control lamp" in the cab and
B. departure command by means of the "signalling disc" (pulled stock).

1.1.1 METHOD A:

* The guard gives the signal (blows the whistle).
* The command "close doors" is given by means of the train key.
* All doors close, except the guard's door.
* The guard verifies whether all doors are closed and ensures that no passengers are trapped in the doors.
* The guard presses the "open" button, causing the "green control lamp" in the cab to illuminate.
* The driver will pull away when both the "green control lamp" and the track signal are in the "off" position.
* The guard now removes the train key and presses the "close" button, causing this door too to close.

The "green control lamp" serves a two-fold function. It indicates that the exterior doors are closed and at the same time gives the driver the departure command.

1.1.2 METHOD B:

* The guard gives the signal (blows the whistle).
* The command "close doors" is given by means of the train key.
* All doors close, except the guard's door.
* The guard verifies whether all doors are closed and ensures that no passengers are trapped in the doors.
* The guard motions to the driver (or flashes a green torch) to indicate that departure may commence.
* The driver pulls away.
* The guard closes his own door.

2. KINDS OF RISK

The risks listed below have been recognized and are being analysed:

a. Departure through the danger signal and a subsequent serious accident;
b. Injury when boarding a stationary train;
c. Injury when boarding a moving train (along the platform);
d. Injury when getting off a stationary train (along the platform);
e. Injury when getting off a moving train (along the platform);
f. Falling off a moving train (higher speeds/open track).

3. DEPARTURE THROUGH THE DANGER SIGNAL

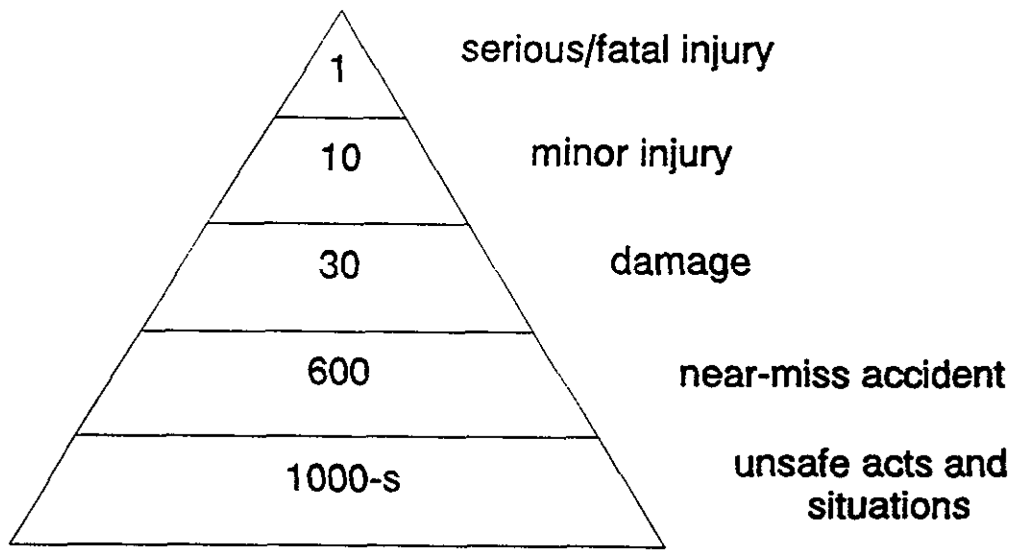
The below information has been derived from the Management Information System Rail Safety (Misos; Ep 4.1).

During the eleven year period from 1981 to 1992 inclusive, the departure command was issued 108 times while the stop signal indicated danger and the trains actually drove through the danger signal.
Note: The incidence of the departure command being given in spite of the stop signal showing danger was probably significantly higher. In these cases, the driver will have averted further consequences.

During the period under review, a single collision occurred which was caused by the departure command having been issued in spite of the stop signal indicating danger and the train's subsequent departure through the danger signal. Six passengers and two employees were injured in this accident.

The above allows an expectation quotient for such incidents to be derived, which would be once every 11 years. From a statistics point of view, however, the above represents a very narrow basis.

For this reason, the expectation quotient has been re-calculated below, using the so-called accident triangle and basing the calculation on the 108 undesirable events over a period of 11 years (issuing the departure command and subsequent departure through the danger signal).



The accident triangle shows a fatal accident expectation quotient of once every 65 years.

Number of departure procedure per annum (reference year 1987):
On the basis of the average distance between stops (approx. 10.4 km) and the number of train kilometres per day (approx. 285,000 km), the rough number of departure procedures p.a. was calculated and is approx. 10 million. This data makes it possible to calculate the overall expectation quotient for a wrong departure procedure, assuming 10 wrong procedures p.a. The quotient is: 10^{-6}.

Comment:

The information now available also allows the probability of human error to be considered.

RISK ANALYSIS:

Step	Question	Answer
1	Which activity/risk location?	Issuing departure command when stop signal at danger and subsequently actually driving through danger signal
2	What can go wrong?	Collision/crash train/train or train/shunting equipment
3	What chance is there of such an incident taking place? 1 = very small chance 2 = small chance 3 = average chance 4 = fair chance 5 = large chance	C = 1 Justification: Misos indicates one incident every 11 years; accident triangle reveals one incident every 65 years.
4	What would be the consequences of such an incident taking place? At best: At worst: most probably:	At best: material damage At worst: casualties/injured persons and vast material damage Most probably: vast material damage; seriously injured persons
5	How severe do you estimate these most probable consequences to be? 1 --> 10 moderate very severe	E = 9
6	R = C * E	R = 1 * 9 = 9
7	What criterion must the risk satisfy?	E < 7

Step	Question	Answer
8	Which measures are feasible (in addition) to limit the risk? 1. Source elimination 2. Prevention 3. Correction 4. Damage limitation	Tackle source: Do not permit cross-over train manouvres. (This would render the operation of railways virtually impossible). Preventive: (Selective ?)implementation of New Generation Automatic Train Control, making accidental passing through a danger signal impossible. Corrective: Substantial reduction in the incidence of driving through danger signals possible only through technical measures. (Under discussion with respect to chance of human error). Limitation of damage: (Selectively) make trains move at lower speeds (40 km/h) at train departure sites.
9	To what degree is the risk reduced by each measure? R1 = C1 * E1 Risk reduction: {(R-R1)/R} * 100%	Implementation of New Generation Automatic Train Control: Risk matches chance of technical failure. Selectively making trains drive at lower speeds at train departure sites (this measure would render the current level of services virtually impossible). E_{new} = 4 $Risk_{new}$ = 1 * 4 = 4 Risk reduction: 55%
10	Cost - benefit analysis per measure or combination of measures? Conclusion/recommendation	The cost of integral implementation of New Generation Automatic Train Control is estimated to be around Dfl. 1.5 to 2 billion.

4. BOARDING/GETTING OFF A STATIONARY TRAIN

Only incidents of a more serious nature have been entered into the Management Information System Rail Safety. The database containing all daily irregularities shows, on average, each year:

24 injured persons due to "boarding a stationary train";
13 injured persons due to "getting off a stationary train".

On average, NS processes 900,000 (1992) travellers each day, all of whom board and get off a train at least once.
The mean chance (in order of magnitude) of an average passenger sustaining injury when boarding/getting off a stationary train per annum is: $4 * 10^{-5}$.
The severity of such incidents: usually slight injuries.

RISK ANALYSIS:

Step	Question	Answer
1	Which activity/risk location?	Boarding/getting off a stationary train.
2	What can go wrong?	Passengers sustain injuries.
3	What chance is there of such an incident taking place? 1 = very small chance 2 = small chance 3 = average chance 4 = fair chance 5 = large chance	C = 5 (large chance) Justification: Number of incidents <u>reported</u> each year: 46; number of injured persons each year: 37.
4	What would be the consequences of such an incident taking place? At best: At worst: most probably.	at best: no injury/no material damage at worst: seriously injured most probably: slight injuries (grazes)
5	How severe do you estimate these most probable consequences to be? 1 --> 10 moderate very severe	E = 1

Step	Question	Answer
6	R = C * E	R = 5 * 1 = 5
7	What criterion must the risk satisfy?	E < 7 R < 10
8	Which measures are feasible (in addition) to limit the risk? 1. Source elimination 2. Prevention 3. Correction 4. Damage limitation	Tackle source: access from the platform to the train and vice versa at the same level; gap between platform and train as small as possible. Adjustment: Fit rolling stock with grips.
9	To what degree is the risk reduced by each measure? R1 = C1 * E1 Risk reduction: {(R-R1)/R} * 100%	Tackle source: Risk becomes negligible. Adjustment: Fitting grips would cause an estimated decrease of 50% in the number of incidents. The severity remains the same. R_{new} = 4 * 1 = 4 Risk reduction: 20%
10	Cost - benefit analysis per measure or combination of measures? Conclusion/recommendation:	Tackle source: unaffordable. Corrective measure (fitting grips): Implement only if costs are low (more customer friendly). Improve boarding/exiting conditions for rolling stock (platforms). In view of the small chance of sustaining injury and the slight nature of such incidents, low risk priority is given to incidents taking place when boarding/getting off stationary trains.

5. BOARDING/GETTING OFF A MOVING TRAIN

The Management Information System Rail Safety (Misos) reveals that 24 incidents have occurred in a period of 11 years.

Consequences:	- no injuries	: 1
	- injured	: 9
	- seriously injured	: 13 (invalidity)
	- killed	: 1

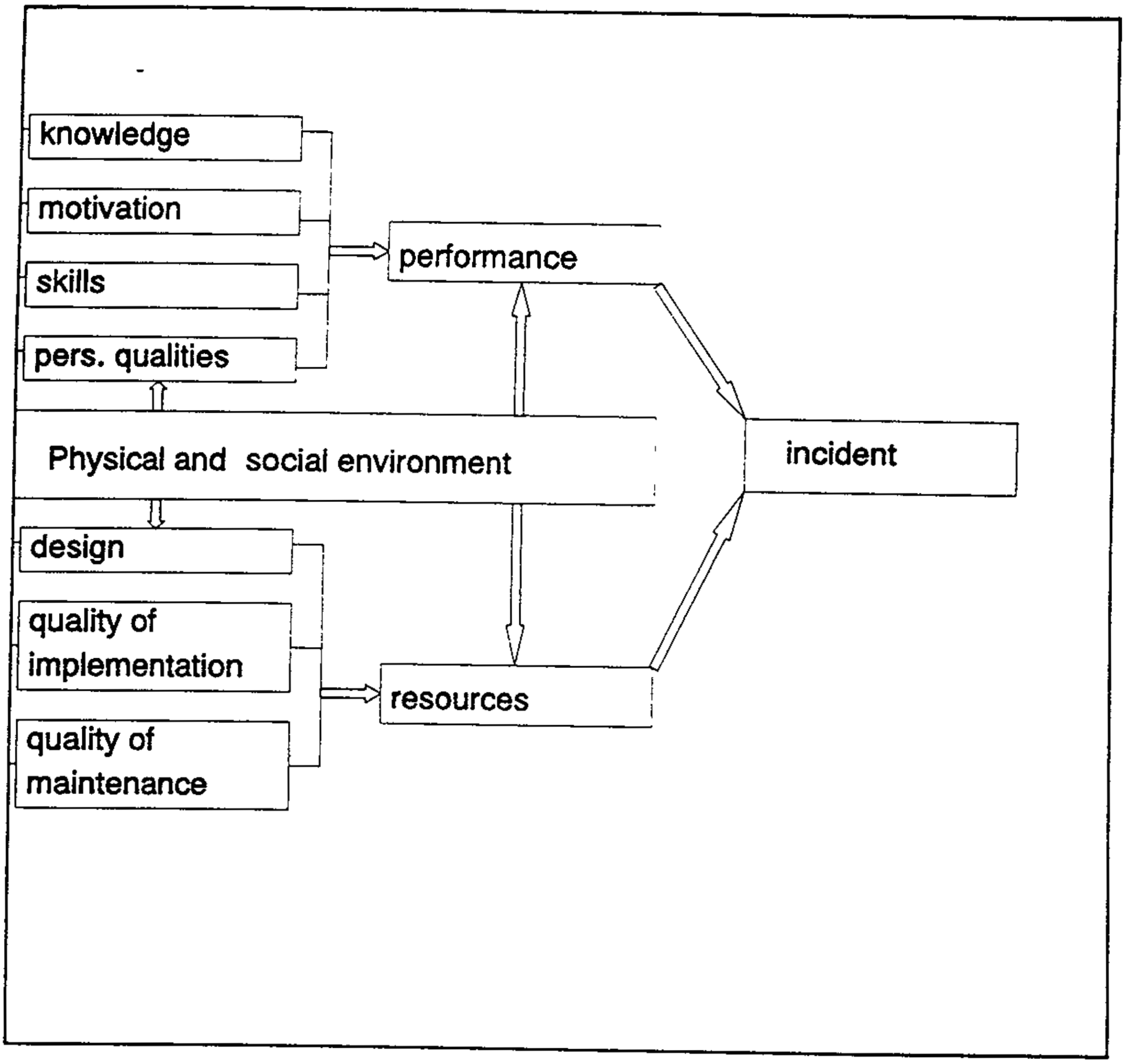
Only incidents of a more serious nature have been entered into the Management Information System Rail Safety. The database containing all daily irregularities shows, on average, each year:

6 injured persons due to "boarding a moving train";
7 injured persons due to "getting off a moving train".

RISK ANALYSIS:

Step	Question	Answer
1	Which activity/risk location?	Boarding/getting off moving trains.
2	What can go wrong?	Serious injuries may be sustained (invalidity).
3	What chance is there of such an incident taking place? 1 = very small chance 2 = small chance 3 = average chance 4 = fair chance 5 = large chance	C = 3 (failure frequency 0.5 to 2 years). Justification: Misos (period of 11 years) 1 dead, 9 injured, 13 seriously injured. Database (daily irregularities): 13 injured persons per year.
4	What would be the consequences of such an incident taking place? At best: At worst: most probably:	at best: no injury at worst: fatal accident most probably: several injured persons, of whom at least one seriously injured (invalidity) each year.

Step	Question	Answer
5	How severe do you estimate these most probable consequences to be? 1 --> 10 moderate very severe	E = 9 Justification: see above.
6	R = C * E	Risk = 3 * 9 = 27 (class I)
7	What criterion must the risk satisfy?	E < 7
8	Which measures are feasible (in addition) to limit the risk? 1. Source elimination 2. Prevention 3. Correction 4. Damage limitation	See page 12 and 13. The measures given will also have a preventive effect on passengers' behaviour.
9	To what degree is the risk reduced by each measure? R1 = C1 * E1 Risk reduction: {(R-R1)/R} * 100%	Estimated decrease: Management Information System Rail Safety (period of 11 years): 1 dead and 9 seriously injured. Database (daily irregularities) (period of 1 year): 6 injured persons. C_1 - 3 E_1 = 6 ---> R_1 = 18 Risk reduction = 66%
10	Cost - benefit analysis per measure or combination of measures? Conclusion/recommendation:	A number of adjustments have been/are being carried out. The risk analysis clearly shows that measures must be taken. The Risk Analyses Model below has been used to trace any direct and indirect causes.



The direct causes are the result of the following indirect causes:

Performance ----> knowledge:

The operation of the door systems differs for various types of rolling stock. Even within the same type, small operational differences exist which are nevertheless crucially important. Uniform operation would also benefit passenger safety.

Resources ----> design:

When the guard releases the key he uses to issue the "close exterior doors" command, the key springs back and the command is cancelled.

Not all exterior doors are included in the "central locking" circuit (e.g. luggage compartment doors).

The doors of older types of rolling stock can be opened while the train is still moving.

Conclusions/recommendations:

- Adapt/fit exterior passenger doors such that, when closed, there is no possibility of holding on to them from the outside.

- Adapt/fit door systems on all types of rolling stock such that both functional and operational uniformity is created (e.g. locking is not released).
Estimated decrease in the number of victims: 1 dead and 8 seriously injured (period: 11 years).

- Incorporate all exterior doors in central locking circuit.

- Close the open Head Guard's door as soon as it is safe to do so during the train's departure.
Estimated decrease in the number of victims: 1 seriously injured (period: 11 years).

- Exterior passenger doors can only be opened once the train has (virtually) stopped alongside the platform.
Estimated decrease in the number of victims: 6 injured (period: 1 year).

6. FALLING OFF A MOVING TRAIN (higher speeds, open track!)

The Management Information System Rail Safety (period of 1981 to 1992 inclusive; 11 years) provides a single incident in which a passenger was injured as a result of falling from a moving train. In terms of statistics, this is too narrow a basis.
In 1992, there were 20 reports of an "open door in the course of the journey". During the same year, there were 50 door safety malfunctions.

Theoretical approach to "falling from a moving train", given 20 x "open door in the course of the journey":

Number of peak hours with balcony full: 5 days a week, 3 hours a day.
Number of operation hours per day: 18.

Assumption: a passenger leans against a door and falls from the train as a result of this door not being closed: 5%.

Using the above data and assumptions, the expectation quotient for a passenger falling from a train has been calculated below.

$$20*\frac{3}{18}*\frac{5}{100}(5\%)=0.17$$

The calculated expectation quotient corresponds to a chance of once every 6 years. If the assumption (5%) is changed to 1%, the expectation quotient becomes:

$$20*\frac{3}{18}*\frac{1}{100}(1\%)=0.0333$$

once every 30 years.

With the above expectation quotients, it is now possible to calculate the annual risk (or rather, the chance) run by an individual passenger.
Basing the calculation on the number of passenger kilometres in 1990 and assuming that a passenger travels 20,000 kilometres p.a. by rail, the calculated individual risk is:

$$\frac{0.17}{11.06*10^{9}}*20000=3*10^{-7}$$

(this applies to the assumption of 5%)

$$\frac{0.0333}{11.06*10^{9}}*20000=0.6*10^{-7}$$

(this applies to the assumption of 1%)

Theoretical approach to "falling from a moving train", given 50 x door safety malfunctions p.a.:

If we consider a door safety malfunction to be an undesirable event, the accident triangle may be used to estimate the chance of a fatal accident: once every 12 years.

RISK ANALYSIS:

Step	Question	Answer
1	Which activity/risk location?	Open door in the course of a journey (high speed/open track).
2	What can go wrong?	Passenger falls from moving train.
3	What chance is there of such an incident taking place? 1 = very small chance 2 = small chance 3 = average chance 4 = fair chance 5 = large chance	C = 1 Justification: See the above calculations of expectation quotients.
4	What would be the consequences of such an incident taking place? At best: At worst: most probably:	at best: slight injury at worst: death most probably: serious injuries / death
5	How severe do you estimate these most probable consequences to be? 1 --> 10 moderate very severe	E = 9
6	R = C * E	R = 1 * 9 = 9
7	What criterion must the risk satisfy?	E < 7 R < 10
8	Which measures are feasible (in addition) to limit the risk? 1. Source elimination 2. Prevention 3. Correction 4. Damage limitation	Only low cost measures. Justification: The theoretical individual risk (or rather, chance), as calculated above, would amply bear comparison with the criteria laid down in the National Environment Policy Plan[1].

Step	Question	Answer
9	To what degree is the risk reduced by each measure? R1 = C1 * E1 Risk reduction: {(R-R1)/R} * 100%	not applicable
10	Cost - benefit analysis per measure or combination of measures? Conclusion/recommendation:	Maintain the current safety level. Improve the safety level if costs are low.

[1] Falling from a moving train represents only part of the total transport risk.

SUMMARY

Departure through danger signal and subsequent serious accident:

To tackle the source of this problem, train departures in spite of the stop signal indicating danger must be prevented. A substantial reduction in the incidence of trains driving through a danger signal (when departing) is possible by implementing technical measures (safety).

The severity may be decreased by selectively making trains drive at a lower speed at train departure sites. This measure would render the level of services virtually impossible.

Injury when boarding/getting off a stationary train:

With 37 people injured, this category unfortunately scores high.
A measure of relativity should be applied, however. The number of passengers boarding or getting off each day is 900,000! The injuries sustained are, on the whole, only slight.
Tackling the problem at source is possible. The access/exit conditions rolling stock/platform could be improved, but in view of the enormous costs associated with this measure, this would only be feasible in the long run.
Corrective measures (e.g. provide passengers with grips) might form the solution.

Injury when boarding/getting off a moving train:

Such action by a number of our passengers regularly causes seriously injured people. This situation must and can be improved.

- Adapt/fit exterior passenger doors such that, when closed, there is no possibility of holding on to them from the outside.

- Adapt/fit door systems on all types of rolling stock such that both functional and operational uniformity (for passengers as well as employees) is created (e.g. locking is not released when the train key is).

- Incorporate all exterior doors in central locking circuit, with the exception of cab doors, unless these are to become exterior passenger doors in the future (ICM).

- Close the open Head Guard's door as soon as it is safe to do so during the train's departure.

- Exterior passenger doors can only be opened once the train has (virtually) stopped alongside the platform.

Falling off a moving train (higher speeds, open track):

Maintain the current safety level; if costs are low, improve.

International Rail Safety Conference

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9313

Jack Rose

Staff accident safety analysis

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

STAFF ACCIDENT SAFETY ANALYSIS

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SAFETY SEMINAR
26-28 OCTOBER 1993, ANGERS, FRANCE

LONDON UNDERGROUND LIMITED

STAFF ACCIDENT SAFETY ANALYSIS

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STAFF ACCIDENT SAFETY ANALYSIS

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SUMMARY

This paper is about the techniques and database used for the quantified risk analysis of staff accidents on London Underground. The paper will include details of the human factors work involved in this and in the overall risk analysis for London Underground, the results of the staff accident analysis both in terms of the risks to the workforce and the individual and managerial root causes of the accidents

INTRODUCTION

As part of London Underground Limited's (LUL) ongoing safety programme the Safety and Quality Directorate has developed a set of fault trees and event trees that identify the major hazards associated with the operation of the LUL railway system, and quantify the risks in terms of likely fatalities. The level of detail incorporated into these analytical tools has been progressively expanded and improved during the past two years. LUL has now rationalised its safety programme onto a more structured basis, whereby decisions on expenditure programmes can be aided by analysis of the relative cost and effectiveness of particular measures in terms of safety. This enables LUL to move away from an essentially reactive stance in relation to safety expenditure, to a proactive one where areas of vulnerability are identified in advance.

Since the 1987 Kings Cross fire, and the publication of the public inquiry (Fennell) Report a year later, LUL had naturally given a high priority to directing those safety measures towards the improvement of passenger safety. However, the quantified risk assessment (QRA) work had identified that LUL staff human factors aspects accounted for about 60% of the risk causation and, in addition, staff accident figures were rising quite considerably and represented a sizeable percentage of LUL's short-term risk. While it was recognised that some of the increase in staff accident statistics was due to an improved accident reporting system and better education of the staff to report accidents and incidents, nevertheless, there was a genuine underlying trend upwards that needed to be understood and assessed.

As part of these assessments therefore, models of human reliability within the QRA have been developed. These models do not necessarily assign the causes of errors solely to the operator. Where appropriate wider factors are considered such as the role of management influences. In addition, a separate analysis of the root causes of staff accidents has been carried out.

This report presents the background to all this work and the results of the QRA for staff accidents within LUL and the root causes of the accidents.

HUMAN FACTORS TECHNIQUES

Human factors form a vital input to some of the fault trees. There is very little published data regarding human reliability in the railway industry, and LUL's reporting of human errors is limited. At present LUL only records information through its Incident Reporting System, and most of this is factual information relating to the technical aspects of an incident and its outcome. This reporting system as it stands fulfils the following two functions:

- it records incidents;
- it supports disciplinary proceedings.

It has limited use however in terms of understanding how human performance contributes to incidents. In terms of quantitative assessment, only errors are recorded; there are no records of correct actions and near misses are sometimes (often?) not reported. This is because reported errors are sometimes penalised and there is therefore little incentive for staff to report any errors they may make. As a result only a small fraction of errors are recorded. In addition the factors which contribute to errors are also not recorded.

In terms of providing insight into likely human performance, there are a number of techniques which have been developed over the last decade to assess human reliability. These techniques are of variable quality, applicability and value.

It has been suggested that any useful method for quantifying the human contribution to risk should have the following components:

a large data base of human error data points;

weightings or multipliers for the effects of performance shaping factors (PSFs);

a technique which takes into account the interactions between performance shaping factors.

Human Error Assessment Reduction Technique (Heart)

As a proposed assessment method the Human Error Assessment Reduction Technique (HEART) attempts with varying degrees of success to incorporate the components listed above.

This technique has the following features:

it is based on a sizeable human reliability database;

it provides weighted factors based on the human factors literature;

it combines interactive effects by assuming that human performance will (with one or two notable exceptions) tend to deteriorate when Error Producing Conditions (EPCs) such as conflict of objectives and shortage of time, coincide.

HEART is therefore a pre-processed human reliability assessment technique designed to aid the identification and ranking of EPCs leading to a calculation of the predicted probabilities of task failure.

The method also suggests potential remedial measures that can be applied, should the need arise. The method appears to be producing helpful, face valid assessments that are broadly in line with industrial observation, and which reflects the findings of general human factors literature. For these reasons HEART was considered to be the most appropriate method for quantifying Human Error Probabilities (HEPS) in this study.

Where appropriate, the database used for the 1992 study on LUL tain driver stress was also used to generate HEPS. This database contains information on the perceptions of 356 drivers of the frequency and causation of a number of different errors.

The Technique Outlined

The method is based on a number of assumptions:

- it is assumed that basic human reliability is dependant upon the generic nature of the task performed;

- given ideal conditions, this level of reliability will tend to be achieved consistently with a given nominal likelihood within probabilistic limits;

- given that these ideal conditions do not exist in all circumstances, the human reliability predicted may be expected to degrade as a function of the extent to which the EPCs might apply.

The method concentrates on the more usual additive (and numerically, in practice, multiplicative) nature of EPCs, and assumes that performance will be degraded as the effects of the EPCs are increased. Currently, therefore, the HEART methodology ignores the strengths and direction of potential interactive effects, because generally these are of low consequence with regard to the overall nature of the tasks being investigated. The approach is broadly conservative, i.e. it errs in the direction of higher probabilities of predicted failure than might otherwise be warranted by detailed assessment of potential interactions.

In order to simplify the model, and because it is generally the case, EPCs are only predicted to lower human reliability.

A major assumption within HEART is that EPCs have generally consistent effects on human reliability. A review of the human factors literature certainly indicates that the reported effects of EPCs (acting in isolation or in combination) are remarkably consistent in a relative sense, even though absolute levels of reliability are markedly different. There are some EPCs about which little is currently known and it is recognised that some of these can play a significant role in determining human reliability. Efforts have been made in the HEART method to identify these EPCs and attach a likely strength. This anticipates that the literature will catch up with the need to quantify such effects.

In using the HEART technique for this study a number of assumptions have been made:

- staff do not in any situation have an unlimited amount of time to perform tasks;

- it is assumed that all staff have a minimum of 6 months experience with the range of tasks (dealing with the different types of fire, and certain events on the Victoria line are the only scenarios in which experience is considered as an EPC);

- when considering the effects of carrying out monotonous tasks it is always assumed that the driver has been carrying out these tasks for a minimum of ~½ hrs;

- stress is not generally considered as an EPC except in the case of fires and door opening hazard.

Assessing the Accuracy of Heart Probabilities Using Absolute Probability Judgements

In this study the HEPS calculated using the HEART method are checked for accuracy using Absolute Probability Judgements (APJ). APJ, also known as Direct Numerical Estimation is the most direct approach to the quantification of HEPS. It relies on the utilisation of experts to estimate HEPS, based on their particular knowledge and experience.

The Rationale for Using Expert Judgement To Generate Human Error Probabilities

The primary reason for using expert judgement in human reliability assessments is that usually little or no useful human error probability data exists. Also the data available are often difficult to interpret due to insufficient knowledge of the circumstances which contributed to them. Therefore an alternative method must be found for estimating HEPS for use in probabilistic risk assessments. One way of securing such data is to use expert opinion or judgement. This approach has already been used in a number of probabilistic risk assessment studies.

The rationale for using expert judgements is that experts have knowledge and experience which can be translated into quantitative estimates of the probability of occurrence of an event.

In using such a method there are two primary requirements of any expert:

they must have substantive expertise i.e. the expert must know the subject matter and area sufficiently well;

they must have normative expertise i.e. the expert must be able to accurately translate this expertise into probabilities.

If the experts know the subject matter sufficiently well but are not used to calculating probabilities it is acceptable to use a facilitator who can attempt to ensure that the probabilities elicited reflect as far as is possible the experts' knowledge and experience of the area. For this purpose driver and station staff trainers are used in this study. Since the trainers selected are not used to calculating probabilities for events in this way a facilitator is used.

Absolute Probability Judgement Method

There are two forms of APJ, namely Group APJ Methods, and the Single Expert Method (often referred to as engineering judgement).

Group APJ Approaches

Where practicable it is recommended that groups of experts be used to generate HEPS. They are considered to be less prone to the biases and knowledge limitations of a single expert. There are four major group methods:

Aggregated Individual Method;
Delphi Method;
Nominal Group Technique (NGT);
Consensus Group Method.

In this study the Consensus Group Method was used to check the numbers calculated from HEART.

Consensus Group Method

In a consensus group each member contributes to the discussion, but the group must arrive at an estimate upon which all members of the group agree. This method maximises information sharing but necessitates experts to be brought together. One of the problems with consensus groups is that personality variables and other biases may come into play, affecting how the group ultimately reaches agreement (Reference 18). It is possible that there may be a situation of deadlock (i.e. consensus simply cannot be reached). In such situations individual estimates must be statistically aggregated.

Minimising the Effects of Bias in Expert Judgement

The use of a facilitator during an expert group session is one of the major ways to reduce the problems of bias in expert judgement. The primary function of the facilitator is to manage an expert session without the facilitator themselves providing any quantitative estimates.

Three major biases in Expert Judgement have been identified:

the overconfidence bias (also referred to as conservatism). This can cause the uncertainty bands to be too narrow, and generally causes an under estimation of very high failure probabilities and an over estimation of very low probabilities.

the availability bias. This occurs when experts tend to base their estimates on the ease with which they can think of previous occurrences of the events in question. These experts may be (erroneously) influenced by disproportionate experience.

the anchoring bias. This occurs when an expert or expert group starts with some initial value suggested by one member, and adjusts this value to derive the best estimate, frequently failing to sufficiently adjust it. In order to counteract this bias it is suggested that the group discuss the task before quantifying the HEP.

There are several other biases which may affect the outcome of this task, however most of these can be significantly reduced by the use of a facilitator.

APJ Procedure

The overall APJ procedure is as follows:

Selection of Experts

It is essential that the experts making the judgements are familiar with the tasks to be assessed. These experts can either be individuals who are currently or were formerly involved with these tasks. Instructors or trainers generally meet these requirements and for this exercise driver and station staff trainers were selected. The use of such a group helped avoid some of the biases described above especially the availability bias which is frequently observed amongst those managers and supervisors involved with disciplinary proceedings.

The number of experts needed to make the judgements cannot be stated unequivocally. It is recommended that as many experts as is practicable should participate. It is suggested that six experts would be sufficient for direct estimation. For the purposes of this exercise four trainers were used in each session. A total of six sessions were run.

Preparation of Task Statements

Well defined task statements are a critical aspect of the APJ estimation procedure. The clearer and more succinct the tasks are specified, the less they will be open to individual interpretation by experts while making their judgements.

The task statements in this exercise include:

a clear definition of the task or scenario (reference was made to the base event in the fault tree);
where appropriate, more information was provided in terms of the top event;
information on the effect of the different EPCs.

These APJ sessions only intended to cross check the HEPS and not the conditions which might give rise to these errors.

Preparation of Response Booklets

A key consideration when using APJ is the type of scale on which experts will indicate judgements. For this purpose the standard APJ Estimation Scale was used (see Table 6.5).

Development of Instructions for Subjects

The following information was given to experts at the beginning of the session:

the purpose of the session was outlined;
instructions were provided on how to use the APJ scale.

Obtaining Judgements

Groups of driver and station staff trainers were asked to discuss each of the scenarios presented in turn and arrive at a consensus estimate. Having arrived at a consensus estimate they were then asked to mark their probability rating on the scales provided.

Advantages of using APJ

The principle advantages of APJ are as follows:

the technique has been shown to provide accurate estimates in other fields;

the method is relatively quick to use, yet it allows as much detailed discussion as experts think fit, and, if documented, this qualitative information can often be used at a later stage.

FACTORS AFFECTING PERFORMANCE AT WORK

It is clear that the LUL drivers' work (like that of many in the railway industry) demands a high level of knowledge, constant attention, and vigilance, while carrying out a repetitive cycle of activities in a constrained and monotonous environment. The sequences of activities are in effect rule driven with each stage of the operators work defined by a set of procedures and regulations. In failure or breakdown situations however high demands are made on the drivers' ability to process information, perceptions and decision making capabilities.

In such an environment perhaps the most common source of errors is simply a lack of appropriate knowledge or skill. However, even when the behaviour is well known and practised, mistakes can still occur. There are several common types of errors in relation to skilled routines as illustrated below:

- the person selects the wrong routine e.g. the driver at a station closes the doors before checking the mirror or monitor;
- a stronger (better established) routine replaces the intended ones e.g. the driver overspeeds after time out of the trains' speed control after tripping the system (SCAT) before reaching the next signal;
- two actions compete for the next step in the routine and a curious blend of actions is produced;
- the person omits a key action in the routine;
- the person loses their place in the sequence and either jumps ahead omitting an action or repeats a completed action;
- the person forgets intention and the sequence stops;
- the person has the right intention but works with the wrong object.

Routine behaviour often has to be overridden and other newer behaviours have to be acted out. This requires the persons' attention and conscious control (this could be a particular problem for drivers on the Victoria line particularly when implementing restricted manual control). However, errors can also occur here if the person is distracted or attends to the wrong aspect of the situation. In the first case, more established but inappropriate routines may replace the new behaviour and in the second, control over older more established behaviour may be ineffective and the new behaviours fail. It may be that differences in accident risk may reflect individual differences in this ability to respond to the relevant stimuli.

When calculating human error probabilities using HEART it is necessary to consider the different EPCs to be included in the analysis. The EPCs included in this assessment are based on evidence:

- from general human factors literature;
- from available mass transit literature;
- provided by the 1992 LUL report on driver stress (which looked in detail at the factors which affect driver performance).

Given the number of events detailed in the fault trees it is clear that a wide range of factors will influence the performance of staff at work. The most commonly reported EPCs in the HEART calculations are discussed below and include:

- tiredness and fatigue;
- lack of concentration and distractions;

lack of motivation and low morale;
intentional behaviour;
carrying out boring, repetitive tasks for long periods of time;
individual hazard awareness and perception of risk;
stress;
time pressures;
over reliance on safety support systems.

Tiredness and Fatigue

Of all the factors affecting driver performance, the problems associated with the organisation of work have received the most attention. The majority of train operators in Western countries report difficulties arising from the way in which their work is organised. Many of these difficulties concern the fact that shift working is required to provide a punctual round-the-clock service for the public. This involves:

adhering to time schedules;
working with variable start times;
working with irregular operational hours.

Many physiological functions, and possibly related psychological processes appear to operate cyclically. These cycles are driven by a number of internal clocks and synchronised against various external time markers. Many approximate to 24 hour cycles and map onto the day/night pattern of activity. Shift work superimposes an artificial pattern of activity onto these natural and social cycles. Problems arise when the person has to work when naturally they would be sleeping, and sleep when they would otherwise be working. Shift work can therefore cause a disruption of the shift worker's social life. There is evidence of negative effects of shift work on both physical and mental health, and on social relationships and constructive use of leisure time. However, there are several different types of shift system available, including compressed work weeks, and different systems have different effects on health. Those that ameliorate health effects appear to disrupt social life, while those that allow social adjustment appear to preclude physiological adjustment.

In an investigation of the occupational health of Danish train operators, the negative effects of shift work were found to be the dominant problems affecting performance. Japanese studies have also examined the negative relationship between fatigue, sleeping during driving duty and errors and near misses. The West Germans and the Swedes have also expressed an interest in this issue. The problem of falling asleep while driving has been reported to be worse during night shifts where 11% admitted to such occurrences compared to 5% during early morning shifts and 1% during day shifts (Reference 25). Similarly an analysis of 34 near accidents found that about 75% of the recorded errors occurred between 24.00 and 06.00hr. In an analysis of automatically induced braking incidents, two maxima were identified: one at 03.00hr, and the other at 15.00hr.

In support of these general findings, the 1992 LUL driver stress report has also directly identified feeling tired and fatigued as states or feelings which may contribute to driver error on LUL. Related to this, the way in which work is organised was identified as one of the factors which impinges upon the effective performance of drivers and results in feelings of tiredness and fatigue.

Other evidence provided by the report also suggests that the effects of factors which reflect the organisation of work can express themselves in terms of sleep disturbance and tiredness and fatigue.

Lack of Concentration and Distractions

Safe performance depends very much on the driver obeying the trackside signals and speed limits. Driver vigilance is therefore extremely important. This importance is reflected by the amount of research that this area has attracted when compared with other areas of railway operation.

An early study based on observations of train drivers at work suggested several reasons why drivers make mistakes. Particular reference was made to passing signals at danger. These included:

- incorrect assessment of position;
- selection of the wrong signal;
- distraction, inattentiveness and forgetfulness.

The study states that monotony (resulting, for example, from the frequent working of a particular route) could lead to a general lowering of vigilance and subsequently a greater likelihood of error. Other studies have argued that boredom resulting from the monotonous nature of the work impairs the ability to effectively process information and is therefore a major contributory factor in driver error.

LUL's 1992 driver stress report explored the causal factors of different types of driver error. Lack of concentration was reported to be one of the main factors perceived to contribute to error. Four different types of concentration were identified,
relating to:

- distraction;
- monotony;
- tiredness;
- intrusive thoughts.

Lack of Motivation or Low Morale

An individual's behaviour is shaped by many other factors in addition to those associated with skill. The nature and strength of their motivation will both direct and drive that behaviour. There are various theories of motivation and its manipulation in management practice. These focus on either content or process. The former deal with the nature of the motivation, often based on an understanding of the person's needs, while the latter describe the mechanisms by which motivational factors affect performance.

The control and modification of safe behaviour often exploit these theories either directly through the design of jobs or through organisational procedures such as incentive schemes.

With reference to the driver it is clear that lack of motivation and low morale like monotony may lead to a situation where relevant information is no longer absorbed from their surroundings. In such cases it is argued that the driver no longer acts on environmental information but rather relies on memory of the track and an instinctive awareness of the tasks which require little conscious thought. If this occurs, any new or vital information may go unnoticed and result in an error being made.

Individual Hazard Awareness and Perception of Risk

There are three logical components to hazard awareness:

knowledge of hazard (knowing that something can cause harm, how it causes harm and why);

perception of risk (generally and also with relation to specific situations);

detection of hazard (preparedness and ability to detect hazard, this is a perceptual as well as a sensory process).

These three components logically interact and increasingly do so with experience. The persons ability to perceive a hazard will depend on their sensory ability and their preparedness in terms of attention and motivation, and both of these, as well as the very act of perception, will depend on the persons' knowledge base.

A driver is very likely to react correctly in a situation which may be potentially hazardous if he is:

alert;
attentive;
motivated;
experienced with a particular hazard (as a result of training or an actual event).

Factors which impinge on these states will obviously increase the likelihood of the driver making an error.

Perception of Risk

The evaluation of any risk is dependent on the persons' or groups' perception and knowledge of that hazard, and in turn their experience of that or similar hazards. The role of cognitive processes in the evaluation of risk means that its outcome may be different in kind or degree from the more formal calculations of risk estimation. The evaluation of risk is dependent on who the assessor is and the overall process of risk assessment may be fundamentally different when applied to individual and social behaviour than when applied to the behaviour of engineering systems. This was highlighted in the 1992 driver stress report which revealed that drivers perceptions of errors are influenced by a number of factors not least the likelihood that they will be detected.

Intentional Actions

When considering the impact of human performance on a system it is essential to consider the differences between errors which occur as a result of lapses or mistakes and violations which occur as a result of a conscious action. Violations are the deliberate deviation of planned actions from procedures, rules, laws and accepted practice. Non-malevolent violations may include routine infringements of safety rules and practices for e.g. habitual corner cutting. There are also exceptional violations which occur in response to unusual or emergency situations. We know relatively little about why people commit non-malevolent violations. However, the factors which will influence such behaviour must include: beliefs and attitudes, risk-taking behaviour, and the effects of group norms. These factors are all closely tied up with the concept of *motivation*.

With regard to LUL drivers these actions may be the result of mistaken priorities i.e. irreconcilable goals or objectives such as safety and responsibility and the pressures to manage time schedules and mitigate the effects of delays and late running.

The 1992 driver stress report illustrates clearly that drivers discriminate between different errors using a number of criteria. These criteria include perceived consequences:

for passenger safety;
for the running of the service;
for the detection of error;
for subsequent disciplinary action.

The probability that drivers will intentionally ignore certain rules and regulations is found to be largely determined by these factors.

The 1992 driver stress report also gained insight into the problems or sources of stress experienced by drivers in relation to their work. A variety of problems were identified. One of the biggest problems areas discussed by drivers was the problem of delays and late running. This largely referred to the negative effects of such delays and included:

the effects of being immobilised for long periods;
the disruptive effects on meal reliefs and life outside work;
the negative effects on passenger behaviour.

Added to these problems was the perception by drivers that they feel continually pressured to keep the service running generally and to time. In order to manage this many drivers admitted that they would intentionally ignore certain rules and regulations, for example certain speed restrictions.

Stress

The use of the term stress represents a convenient economy of description and explanation. Many believe that stress exists in the person's recognition of their inability to cope with the demands of the (work) situation and in their subsequent experience of discomfort. Stress is thus not an observable or discrete event. It is not a physical dimension of the environment, a particular behaviour, or a pattern of physiological response. People's behaviour under stress has been the subject of much investigation. While there is no reliable formula for exactly what any one person will do, there are some general principles. These are listed below.

in a situation of severe stress the person may attempt to escape from that situation, become aggressive or freeze;

in less stressful situations, the person will decide on their main task (among the many they are engaged in) and focus down on it. Performance of this main task may actually improve while that of other tasks is impaired;

how the person reacts will depend on a number of factors, such as whether they work as part of a team, how committed they are and how they are managed.

In this study while many of the EPCs considered may collectively give rise to stress, the experience of stress is generally not assumed in this study except in the case of door opening and fires. This is because the experience of stress was directly cited as a cause of door opening hazard in the 1992 driver stress report and has been seen to cause problems in emergency scenarios such as fires.

With regard to fires there have been a number of studies investigating how people behave in such situations. Although it is not always possible to predict human behaviour it is obvious from these studies that people do not always behave in a logical or appropriate manner. These studies also reveal that training of personnel to deal with emergency situations and the various permutations that can occur dramatically improve their capability to respond effectively.

Time Pressures

Time pressure has been reported to be one of the most significant stresses which people experience during their working lives (Reference 30, 31). There are many studies which have demonstrated that time pressure can impair human performance and give rise to error.

There is evidence that the nature of the task to be completed is affected by time pressures. It would appear that easy tasks can improve under time pressures whereas complex tasks are impaired. Furthermore, in most real life situations, time pressure is only one aspect of a complex situation, and the extra demands it imposes may serve to exacerbate workload problems.

Systematic changes have been identified in the cognitive processes when decisions have to be made under time pressures.

It has been observed that people become increasingly selective when pressured by time and focus only on immediate information upon which they will base there decisions and judgement. The person then has to filter information by increasing selectivity, focusing on a subset of the available information and base the decisions and judgements on that. When time becomes extremely restricted there may be a total change of strategy to handle the situation and reach a judgement. This change of strategy may not be the most appropriate action to take and may result in errors being made.

The problems of managing time and being under time pressures are revealed in many of the driver errors explored in the fault trees. Time pressure is also considered as a problem with regard to the scotch and clip operation.

Over reliance on safety support systems

A commonly heard solution to the problem of human unreliability is to increase the levels of automation. The aim of automation is to replace human manual control, planning and problem solving by automatic devices. However, automated systems are still man-machine systems where human reliability is still an issue. Automation will not cure the problem of human failures. There are at least four areas where the changed role of man in relation to an automated system can lead to potential problems:

> the deterioration of manual skills. With automatic systems the operator is required to monitor and, if necessary, take over control himself. However, manual skills deteriorate when they are not used. Formerly experienced operators may become inexperienced and therefore more subject to error when their skills are not kept up to date through regular practice. In addition, the automation may capture the thought processes of the operator to such an extent that the option of switching to manual control is not considered;
>
> the impossibility of maintaining vigilance. Studies have shown that it is impossible for even a highly motivated person to remain vigilant towards a source of information where very little occurs for more than half an hour. With automatic control systems operators

are likely to miss information

the virtual impossibility of checking the automatic decisions. The automatic control system has been introduced because it can do the job better than the operator but the operator is still asked to monitor its effectiveness.

the need to maintain cognitive skills. Cognitive skills e.g. decision making, problem solving and diagnosis, where mental processing is involved, as with manual skills, need regular practice to maintain the knowledge in memory. Such knowledge is also best learnt through hands on experience.

THE RESULTS

The following tables and graphs show the distribution of risks of staff accidents and the root causes of staff accidents :-

STAFF ACCIDENTS RISK ANALYSIS

TOTAL % RISK	TOP EVENT	FATALITY % RISK	MAJOR INJURY % RISK	LTI %RISK	NON-LTI % RISK
30.7	SLIP/TRIP/FALL FROM SAME LEVEL	0.28	34.1	33.6	22.5
19.9	MANUAL HANDLING (OTHER THAN HANDLING RAILS)	0.20	6.5	17.8	38.6
10.9	STRUCK BY MOVING, FLYING OR FALLING OBJECT (NOT RAILS)	0.57	9.3	11.1	12.3
10.8	FALL LESS THAN 2M	18.9	14.7	11.5	4.1
6.5	STRUCK AGAINST FIXED OR STATIONARY OBJECT	0.71	3.4	5.9	11.2
4.5	FALL FROM STATIONARY RAIL VEHICLE	0.12	8.3	5.4	0.75
3.4	COLLISION OF TWO TRAINS IN WORKSHOP/DEPOT	0.33	8.7	4.1	---
2.6	HANDLING RAILS	0.43	2.5	2.4	4.9
2.5	HAND TOOLS (UNPOWERED)	0.09	1.8	2.6	3.1
1.8	ELECTRIC SHOCK OR BURNS (OVERHEAD CABLES)	38.8	0.67	0.32	---
1.6	COLLISION HAZARD IN WORKSHOP/DEPOT	0.07	3.9	1.8	---
1.1	STRUCK BY MOVING RAIL VEHICLE	20.1	0.73	0.37	---
0.95	FALL GREATER THAN 2M	6.8	1.6	0.77	0.34
0.81	ELECTRIC SHOCK OR BURNS (LIVE RAILS)	9.4	0.90	0.48	0.18
0.41	CONTACT WITH MOVING MACHINERY	2.5	0.57	0.30	0.35
0.27	STRUCK BY MOVING VEHICLE (OTHER THAN RAIL VEHICLE)	0.36	0.31	0.28	0.18
0.26	HARMFUL SUBSTANCES	0.97	0.45	0.27	---
0.25	ELECTRIC SHOCK OR BURNS (PLANT/EQUIPMENT)	0.51	0.35	0.21	0.45
0.23	TRAPPED BY OVERTURNING OBJECT	0.78	0.29	0.21	0.21
0.21	DERAILMENT IN WORKSHOP/DEPOT	---	0.54	0.25	---
0.16	BURNT/SCALDED (NOT CHEMICAL OR ELECTRICAL AGENTS)	0.01	0.04	0.07	0.75
0.13	HAND TOOLS (POWERED)	0.09	0.07	0.13	0.06
0.12	FALL FROM MOVING RAIL VEHICLE	---	0.28	0.14	0.03

NOTES

2. These results are for accidents only and do not include the effects of assaults on staff.
1. LTI = Lost Time Injury (an injury that leads to a worker being absent from work for 1 day or more)

STAFF ACCIDENTS RISK ANALYSIS - RISK RANKING OF TOP EVENTS (1) (ALL SEVERITIES)

Note

These risks include all levels of severity, assigning a fractional fatality level to lost-time and non lost-time injuries (Non LTI). The levels of severity involved have been defined in the consequence (event tree) analysis as follows :-

Critical	=	1 (or more) death/year
Major	=	0.1 deaths/year
Minor	=	0 01 deaths/year
Non LTA	=	0.001 deaths/year

Top Event	Risk (deaths/year)	Risk (%)	Risk (% - excluding assault)
Assault	3.33	33.29	——
Slip/trip/fall from same level	2.05	20.49	30.73
Manual handling (other than handling rails)	1 33	13.30	19.93
Struck by moving, flying or falling object (other than rails)	0.725	7.25	10.87
Fall less than 2m	0.722	7.22	10.82
Struck against fixed or stationary object	0.43	4.30	6.44
Fall from stationary rail vehicle	0.303	3.03	4.54
Collision of two trains in workshop/depot	0.225	2.25	3.37
Handling rails	0.175	1.75	2.62
Hand tools (unpowered)	0.168	1.68	2.52
Electric shock or burns (overhead cables)	0.118	1.18	1.77
Collision hazard in workshop/depot	0.101	1.01	1.51
Struck by moving rail vehicle	0.0745	0.74	1.12
Fall greater than 2m	0 0629	0.63	0.94
Electric shock or burns (live rails)	0.0534	0.53	0.80
Contact with moving machinery	0.0267	0.27	0.40
Struck by moving vehicle (other than rail vehicle)	0.0182	0.18	0 27
Harmful substances	0.0172	0.17	0.26
Electric shock or burns (plant/equipment)	0.0168	0.17	0.25
Trapped by overturning object	0.0154	0.15	0.23
Derailment in workshop/depot	0.0139	0.14	0.21
Burnt/scalded (other than chemical or electrical agents)	0.0107	0 11	0.16
Hand tools (powered)	0.0081	0.08	0.12
Fall from moving rail vehicle	0.0079	0.08	0 12
	10.0027	100.00	100.00

STAFF ACCIDENTS RISK ANALYSIS - RISK RANKING OF TOP EVENTS (2) (CRITICAL SEVERITIES ONLY)

Note

These risks include only those levels of severity that will lead to an actual death, rather than an injury. This level of severity has been defined in the consequence (event tree) analysis as Critical.

Top Event	Risk (deaths/year)	Risk (%)	Risk (% - excluding assault)
Assault	0.169	38.36	——
Electric shock or burns (overhead cables)	0.0999	22.68	36.79
Struck by moving rail vehicle	0.0546	12.39	20.11
Fall less than 2m	0.0513	11.64	18.89
Electric shock or burns (live rails)	0 0257	5.83	9.46
Fall greater than 2m	0.0184	4.18	6.78
Contact with moving machinery	0.00687	1.56	2.53
Harmful substances	0.00263	0.60	0.97
Trapped by overturning object	0.0021	0.48	0.77
Struck against fixed or stationary object	0.0019	0.43	0.70
Struck by moving, flying or falling object (other than rails)	0.00153	0.35	0.56
Electric shock or burns (plant/equipment)	0.00138	0.31	0.51
Handling rails	0.00113	0.26	0.42
Struck by moving vehicle (other than rail vehicle)	0.000972	0.22	0.36
Collision of two trains in workshop/depot	0.000898	0.20	0.33
Slip/trip/fall from same level	0.000698	0.16	0.26
Manual handling (other than handling rails)	0.000533	0.12	0.20
Fall from stationary rail vehicle	0.000329	0.07	0.12
Hand tools (unpowered)	0.000238	0.05	0.09
Hand tools (powered)	0.000231	0.05	0.09
Collision hazard in workshop/depot	0.000201	0.05	0.07
Burnt/scalded (other than chemical or electrical agents)	0.000015	0.0	0.01
Derailment in workshop/depot	0.000007	0.0	0 0
Fall from moving rail vehicle	0.0	0.0	0.0
	0.440562	100.00	100.00

STAFF ACCIDENTS RISK ANALYSIS - RISK RANKING OF TOP EVENTS (3) (ALL INJURY SEVERITIES ONLY)

Note

These risks include only those levels of severity that do not lead to an actual fatality and are assigned a fractional fatality level for the lost-time and non lost-time injuries (Non LTI) involved. The levels of severity involved have been defined in the consequence (event tree) analysis as follows .-

Major	=	0.1 deaths/year
Minor	=	0.01 deaths/year
Non LTI	=	0 001 deaths/year

Top Event	Risk (deaths/year)	Risk (%)	Risk (% - excluding assault)
Assault	3 161	33.06	----
Slip/trip/fall from same level	2 0493	21.43	32 01
Manual handling (other than handling rails)	1 3295	13.90	20 77
Struck by moving, flying or falling object (other than rails)	0.7235	7.57	11.30
Fall less than 2m	0.6707	7.01	10.48
Struck against fixed or stationary object	0.4281	4.48	6.69
Fall from stationary rail vehicle	0.3027	3.17	4.73
Collision of two trains in workshop/depot	0.2241	2.34	3.50
Handling rails	0.1739	1.82	2.72
Hand tools (unpowered)	0.1678	1.75	2.62
Collision hazard in workshop/depot	0.1008	1.05	1.57
Fall greater than 2m	0.0445	0.47	0.70
Electric shock or burns (live rails)	0.0277	0.29	0.43
Struck by moving rail vehicle	0.0199	0.21	0.31
Contact with moving machinery	0.0198	0.21	0.31
Electric shock or burns (overhead cables)	0.0181	0 19	0.28
Struck by moving vehicle (other than rail vehicle)	0.0172	0.18	0.27
Electric shock or burns (plant/equipment)	0 0154	0.16	0.24
Harmful substances	0 0146	0.15	0.23
Derailment in workshop/depot	0 0139	0.15	0.22
Trapped by overturning object	0 0133	0.14	0.21
Burnt/scalded (other than chemical or electrical agents)	0.0107	0.11	0 17
Hand tools (powered)	0.0079	0.08	0.12
Fall from moving rail vehicle	0 0079	0.08	0.12
	9.5622	100.00	100.00

STAFF ACCIDENTS RISK ANALYSIS - RISK RANKING OF TOP EVENTS (4) (MAJOR INJURY SEVERITIES ONLY)

Note

These risks include only those levels of severity that will lead to a major (lost-time) injury. This level of severity has been defined in the consequence (event tree) analysis as Major and corresponds to a fatality level of 0 1 deaths/year

Top Event	Risk (deaths/year)	Risk (%)	Risk (% - excluding assault)
Assault	0.624	19 47	-----
Slip/trip/fall from same level	0.879	27.43	34.06
Fall less than 2m	0.38	11.86	14.72
Struck by moving, flying or falling object (other than rails)	0.239	7.46	9.26
Collision of two trains in workshop/depot	0.225	7.02	8.72
Fall from stationary rail vehicle	0.213	6.65	8.25
Manual handling (other than handling rails)	0.167	5.21	6.47
Collision hazard in workshop/depot	0.101	3.15	3.91
Struck against fixed or stationary object	0.0885	2.76	3.43
Handling rails	0.0653	2.04	2.53
Hand tools (unpowered)	0.0474	1.48	1.84
Fall greater than 2m	0.0399	1.25	1.55
Electric shock or burns (overhead cables)	0.0175	0.55	0.68
Electric shock or burns (live rails)	0.0233	0.73	0.90
Struck by moving rail vehicle	0.0191	0.60	0.74
Contact with moving machinery	0.0148	0.46	0.57
Derailment in workshop/depot	0.0139	0.43	0.54
Harmful substances	0.0119	0.37	0.46
Electric shock or burns (plant/equipment)	0 00935	0.29	0.36
Struck by moving vehicle (other than rail vehicle)	0.00829	0.26	0.32
Trapped by overturning object	0.00742	0.23	0.29
Fall from moving rail vehicle	0.00713	0.22	0.28
Hand tools (powered)	0 00186	0.06	0.07
Burnt/scalded (other than chemical or electrical agents)	0.00108	0.03	0.04
	3.20473	100.00	100.00

STAFF ACCIDENTS RISK ANALYSIS - RISK RANKING OF TOP EVENTS (5) (MINOR INJURY SEVERITIES ONLY)

Note

These risks include only those levels of severity that will lead to a minor (lost-time) injury. This level of severity has been defined in the consequence (event tree) analysis as Minor and corresponds to a fatality level of 0.01 deaths/year.

Top Event	Risk (deaths/year)	Risk (%)	Risk (% - excluding assault)
Assault	2 3	44.20	-----
Slip/trip/fall from same level	0 965	18.55	33.24
Manual handling (other than handling rails)	0 807	15.51	27.79
Struck by moving, flying or falling object (other than rails)	0 372	7 15	12 81
Fall less than 2m	0.253	4.86	8.71
Struck against fixed or stationary object	0 236	4 54	8.13
Hand tools (unpowered)	0.0922	1.77	3.18
Fall from stationary rail vehicle	0.0824	1.58	2.84
Handling rails	0.0638	1.23	2.20
Struck by moving vehicle (other than rail vehicle)	0.00732	0.14	0.25
Hand tools (powered)	0.0055	0.11	0.19
Trapped by overturning object	0.00399	0.08	0.14
Electric shock or burns (live rails)	0.0028	0.05	0.10
Burnt/scalded (other than chemical or electrical agents)	0.00276	0.05	0.10
Harmful substances	0 00267	0.05	0.09
Electric shock or burns (plant/equipment)	0.00206	0.04	0.07
Contact with moving machinery	0.00192	0.04	0.07
Fall greater than 2m	0.00156	0.03	0.05
Struck by moving rail vehicle	0.000818	0.02	0.03
Fall from moving rail vehicle	0 000476	0.01	0.02
Electric shock or burns (overhead cables)	0.00025	0.0	0.01
Collision of two trains in workshop/depot	0.0	0.0	0.0
Collision hazard in workshop/depot	0 0	0.0	0.0
Derailment in workshop/depot	0 0	0.0	0.0
	5.203524	100.00	100.00

STAFF ACCIDENTS RISK ANALYSIS - RISK RANKING OF TOP EVENTS (6) (NON LOST-TIME SEVERITIES ONLY)

Note

These risks include only those levels of severity that will lead to a non lost-time injury. This level of severity has been defined in the consequence (event tree) analysis as None and corresponds to a fatality level of 0.001 deaths/year.

Top Event	Risk (deaths/year)	Risk (%)	Risk (% - excluding assault)
Assault	0.243	20.98	-----
Manual handling (other than handling rails)	0 353	30.48	38.58
Slip/trip/fall from same level	0.206	17.79	22.51
Struck by moving, flying or falling object (other than rails)	0.113	9.76	12.35
Struck against fixed or stationary object	0.103	8.89	11.26
Handling rails	0.0445	3.84	4.86
Fall less than 2m	0.0374	3.23	4.09
Hand tools (unpowered)	0.0282	2.44	3.08
Fall from stationary rail vehicle	0.0069	0.60	0.75
Burnt/scalded (other than chemical or electrical agents)	0.00689	0.59	0.75
Electric shock or burns (plant/equipment)	0.00398	0.34	0.43
Contact with moving machinery	0.00311	0.27	0.34
Fall greater than 2m	0.00307	0.27	0.34
Trapped by overturning object	0.00189	0.16	0.21
Struck by moving vehicle (other than rail vehicle)	0.00163	0.14	0.18
Electric shock or burns (live rails)	0.00162	0.14	0.18
Hand tools (powered)	0.00055	0 05	0.06
Fall from moving rail vehicle	0.000309	0.03	0.03
Collision of two trains in workshop/depot	0.0	0.0	0.0
Electric shock or burns (overhead cables)	0.0	0.0	0.0
Collision hazard in workshop/depot	0.0	0.0	0.0
Struck by moving rail vehicle	0.0	0.0	0.0
Harmful substances	0.0	0.0	0.0
Derailment in workshop/depot	0.0	0.0	0.0
	1.158049	100.00	100.00

STAFF ACCIDENTS RISK ANALYSIS - RISK RANKING OF TOP EVENTS (7) (LOST-TIME INJURY SEVERITIES ONLY)

Note

These risks include all those levels of severity that lead to a lost-time injury The levels of severity involved have been defined in the consequence (event tree) analysis as follows :-

Major = 0 1 deaths/year
Minor – 0 01 deaths/year

Top Event	Risk (deaths/year)	Risk (%)	Risk (% - excluding assault)
Assault	2 924	34.78	——
Slip/trip/fall from same level	1.844	21.93	33.62
Manual handling (other than handling rails)	0.974	11.58	17.76
Fall less than 2m	0.633	7.53	11.54
Struck by moving, flying or falling object (other than rails)	0 611	7.27	11.14
Struck against fixed or stationary object	0.3245	3.86	5.92
Fall from stationary rail vehicle	0 2954	3.51	5.39
Collision of two trains in workshop/depot	0.225	2.68	4.10
Hand tools (unpowered)	0 1396	1.66	2.55
Handling rails	0.1291	1.54	2.35
Collision hazard in workshop/depot	0.101	1.20	1.84
Fall greater than 2m	0.04146	0.49	0.76
Electric shock or burns (live rails)	0.0261	0.31	0.48
Struck by moving rail vehicle	0.019918	0.24	0.36
Electric shock or burns (overhead cables)	0 01775	0.21	0.32
Contact with moving machinery	0 01672	0.20	0.30
Struck by moving vehicle (other than rail vehicle)	0 01561	0.19	0.28
Harmful substances	0.01457	0.17	0.27
Derailment in workshop/depot	0.0139	0.17	0.25
Electric shock or burns (plant/equipment)	0.01141	0.14	0.21
Trapped by overturning object	0.01141	0.14	0.21
Fall from moving rail vehicle	0.007606	0.09	0.14
Hand tools (powered)	0.00736	0.09	0.13
Burnt/scalded (other than chemical or electrical agents)	0.00384	0.05	0.07
	8.408254	100.00	100.00

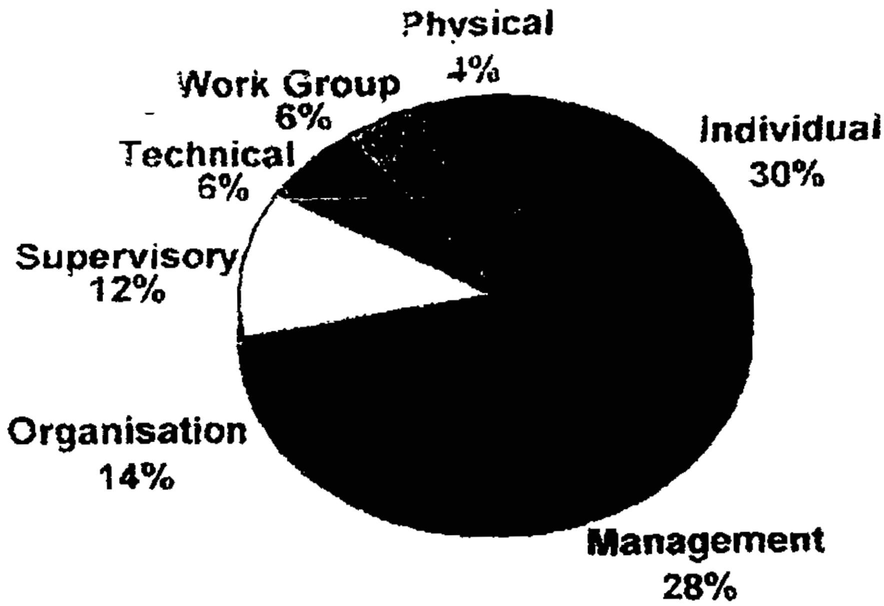
STAFF ACCIDENTS RISK ANALYSIS - STRUCK BY TRAIN RISK RANKING (APPLICABLE TO ALL LEVELS OF SEVERITY)

Note

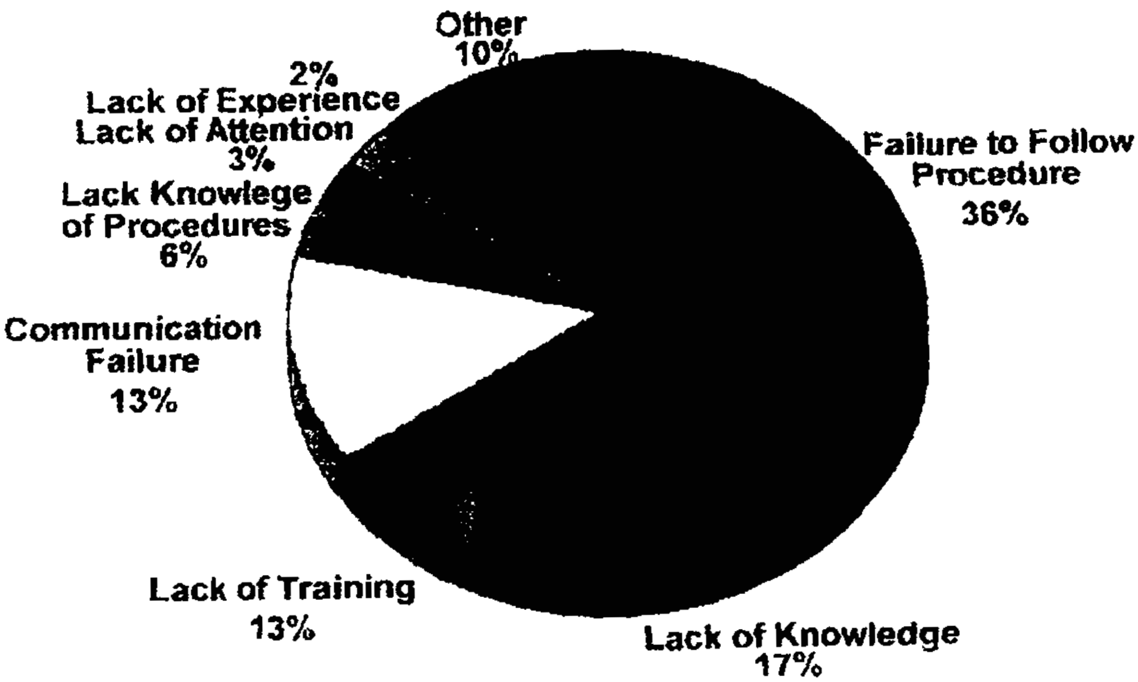
This table shows how the "Struck by Train" risk figures are broken down into the associated events in different working areas of the railway and the frequency and relative risk of those events.

Event	Event Freq. (/year)	Risk (%)
Employee struck on track by moving train/rail vehicle in station	0.07460	22.78
Unauthorised employee on track and struck by train/rail vehicle	0.03740	11.42
Workshop ground shunter struck by train/loco during shunting	0.03190	9.74
Employee struck on platform by moving train/rail vehicle in station	0.02500	7.64
Train borne employee struck by passing train in depot	0.02490	7.60
Train borne employee struck by passing train in workshop	0.02490	7.60
Permanent way gang/employee struck by train/rail vehicle on open track (day)	0.02350	7.18
Permanent way gang/employee struck by train/rail vehicle on open track (night)	0.02280	6.96
Workshop working employee struck by train/loco during shunting	0.01850	5.65
Depot ground shunter struck by train/loco during shunting	0.01770	5.41
Depot working employee struck by train/loco during shunting	0.01040	3.18
Permanent way gang/employee struck by runaway train/rail vehicle on open track	0.00750	2.29
Permanent way gang/employee struck by train/rail vehicle in tunnel	0.00748	2.28
Employee struck by train whilst working underneath	0.00085	0.26
	0.32743	100.00

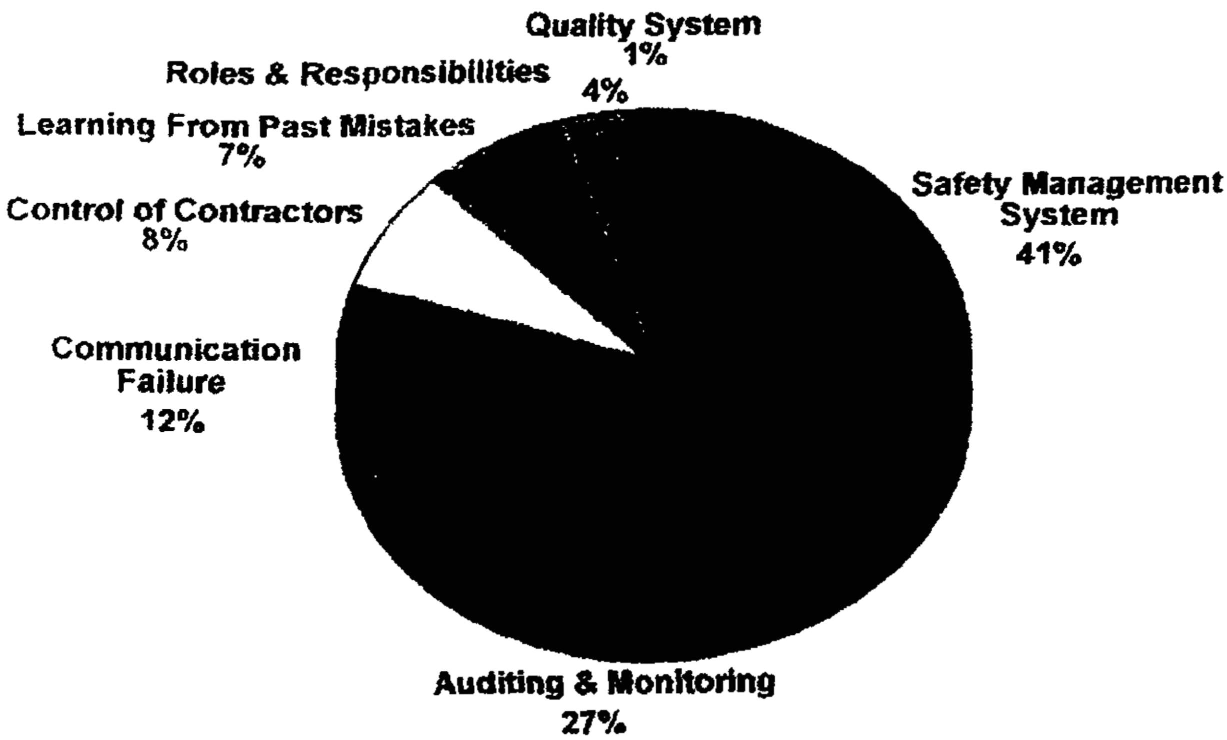
Percentage of Overall Causal Factors of Staff Accidents



Individual Causal Factors

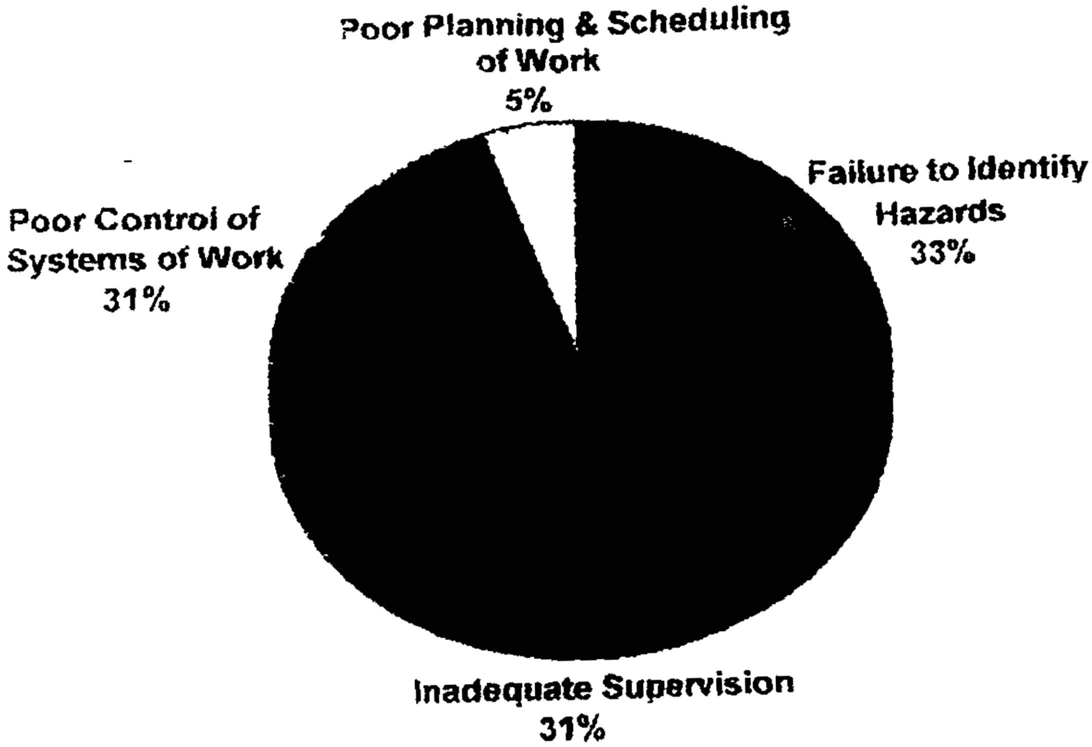


<u>Management Systems Causal Factors</u>

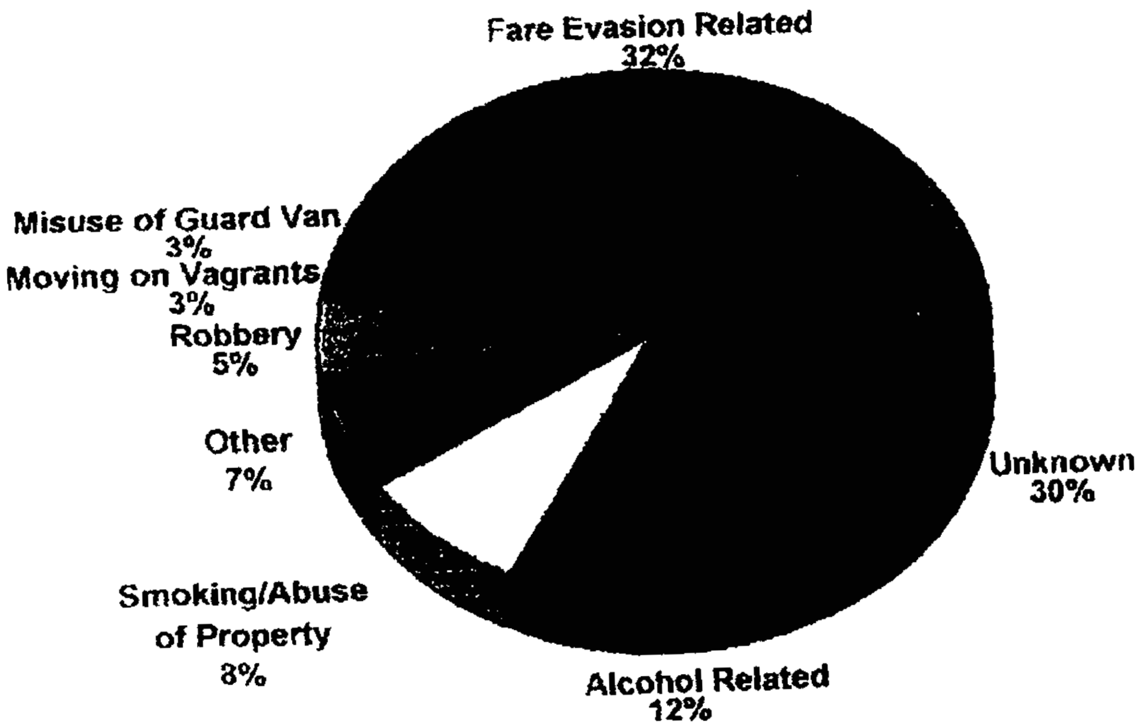


<u>Organisational Causal Factors</u>

Supervisory Causal Factors



Reason Given for Assault



STAFF ACCIDENTS RISK ANALYSIS - TOP EVENTS (ALL SEVERITIES)

EVENT	% RISK
Assault	33.29
Slip/trip/fall from same level	20.49
Manual handling (other than handling rails)	13.3
Struck by moving/flying/falling object (not rails)	7.25
Fall less than 2m	7.22
Struck against fixed or stationary object	4.3
Fall from stationary rail vehicle	3.03
Collision of two trains in workshop/depot	2.25
Handling rails	1.75
Hand tools (unpowered)	1.68
Electric shock or burns (overhead cables)	1.18
Collision hazard in workshop/depot	1.01
Struck by moving rail vehicle	0.74
Fall greater than 2m	0.63
Electric shock or burns (live rails)	0.53
Contact with moving machinery	0.27
Struck by moving vehicle (not rail vehicle)	0.18
Harmful substances	0.17
Electric shock or burns (plant/equipment)	0.17
Trapped by overturning object	0.15
Derailment in workshop/depot	0.14
Burnt/scalded (not chemical/electrical agents)	0.11
Hand tools (powered)	0.08
Fall from moving rail vehicle	0.08

STAFF ACCIDENTS RISK ANALYSIS - TOP EVENTS
(ALL SEVERITIES & EXCLUDING ASSAULTS)

EVENT	% RISK
Slip/trip/fall from same level	30.73
Manual handling (other than handling rails)	19.93
Struck by moving/flying/falling object (not rails)	10.87
Fall less than 2m	10.82
Struck against fixed or stationary object	6.44
Fall from stationary rail vehicle	4.54
Collision of two trains in workshop/depot	3.37
Handling rails	2.62
Hand tools (unpowered)	2.52
Electric shock or burns (overhead cables)	1.77
Collision hazard in workshop/depot	1.51
Struck by moving rail vehicle	1.12
Fall greater than 2m	0.94
Electric shock or burns (live rails)	0.8
Contact with moving machinery	0.4
Struck by moving vehicle (not rail vehicle)	0.27
Harmful substances	0.26
Electric shock or burns (plant/equipment)	0.25
Trapped by overturning object	0.23
Derailment in workshop/depot	0.21
Burnt/scalded (not chemical/electrical agents)	0.16
Hand tools (powered)	0.12
Fall from moving rail vehicle	0.12

DEATHS AND INJURIES EQUIVALENCE TABLE

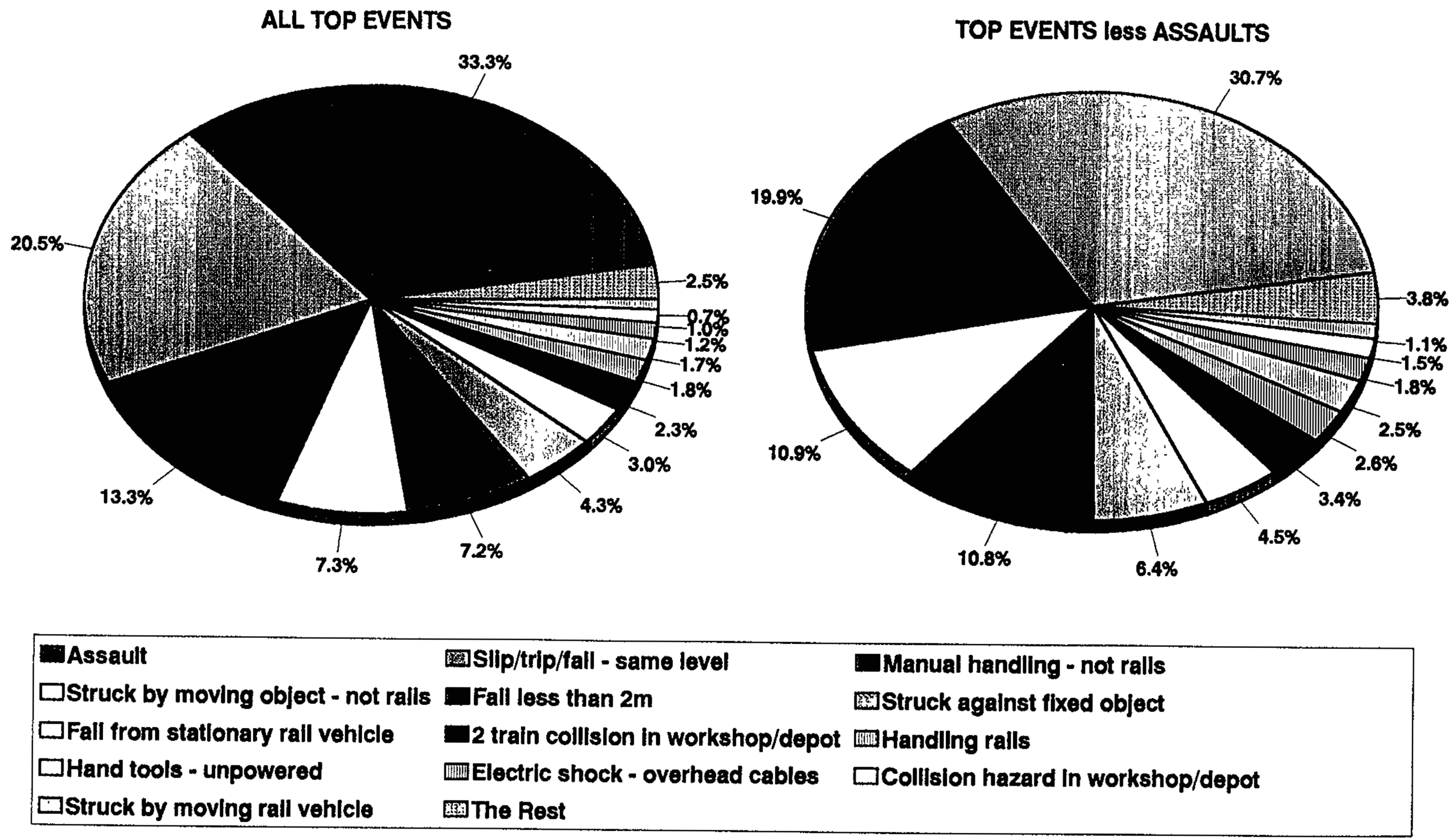
LEVEL OF ACCIDENT	EQUIVALENT DEATHS/YEAR
CRITICAL (FATAL)	1 (OR MORE)
MAJOR INJURY	0.1
MINOR INJURY	0.01
NON-LOST TIME INJURY	0.001

STAFF ACCIDENTS RISK ANALYSIS

TOTAL % RISK	TOP EVENT	FATALITY % RISK	MAJOR INJURY % RISK	LTI %RISK	NON-LTI % RISK
30.7	SLIP/TRIP/FALL FROM SAME LEVEL	0.26	34.1	33.6	22.5
19.9	MANUAL HANDLING (OTHER THAN HANDLING RAILS)	0.20	6.5	17.8	38.6
10.9	STRUCK BY MOVING, FLYING OR FALLING OBJECT (NOT RAILS)	0.57	9.3	11.1	12.3
10.8	FALL LESS THAN 2M	18.9	14.7	11.5	4.1
6.5	STRUCK AGAINST FIXED OR STATIONARY OBJECT	0.71	3.4	5.9	11.2
4.5	FALL FROM STATIONARY RAIL VEHICLE	0.12	8.3	5.4	0.75
3.4	COLLISION OF TWO TRAINS IN WORKSHOP/DEPOT	0.33	8.7	4.1	---
2.6	HANDLING RAILS	0.43	2.5	2.4	4.9
2.5	HAND TOOLS (UNPOWERED)	0.09	1.8	2.6	3.1
1.8	ELECTRIC SHOCK OR BURNS (OVERHEAD CABLES)	36.8	0.67	0.32	---
1.5	COLLISION HAZARD IN WORKSHOP/DEPOT	0.07	3.9	1.8	---
1.1	STRUCK BY MOVING RAIL VEHICLE	20.1	0.73	0.37	---
0.95	FALL GREATER THAN 2M	6.8	1.6	0.77	0.34
0.81	ELECTRIC SHOCK OR BURNS (LIVE RAILS)	9.4	0.90	0.48	0.18
0.41	CONTACT WITH MOVING MACHINERY	2.5	0.57	0.30	0.35
0.27	STRUCK BY MOVING VEHICLE (OTHER THAN RAIL VEHICLE)	0.36	0.31	0.28	0.18
0.26	HARMFUL SUBSTANCES	0.97	0.45	0.27	---
0.25	ELECTRIC SHOCK OR BURNS (PLANT/EQUIPMENT)	0.51	0.35	0.21	0.45
0.23	TRAPPED BY OVERTURNING OBJECT	0.78	0.29	0.21	0.21
0.21	DERAILMENT IN WORKSHOP/DEPOT	---	0.54	0.25	---
0.16	BURNT/SCALDED (NOT CHEMICAL OR ELECTRICAL AGENTS)	0.01	0.04	0.07	0.75
0.13	HAND TOOLS (POWERED)	0.09	0.07	0.13	0.06
0.12	FALL FROM MOVING RAIL VEHICLE	---	0.28	0.14	0.03

STAFF ACCIDENT RISK ANALYSIS - RISK RANKING OF TOP EVENTS (1)

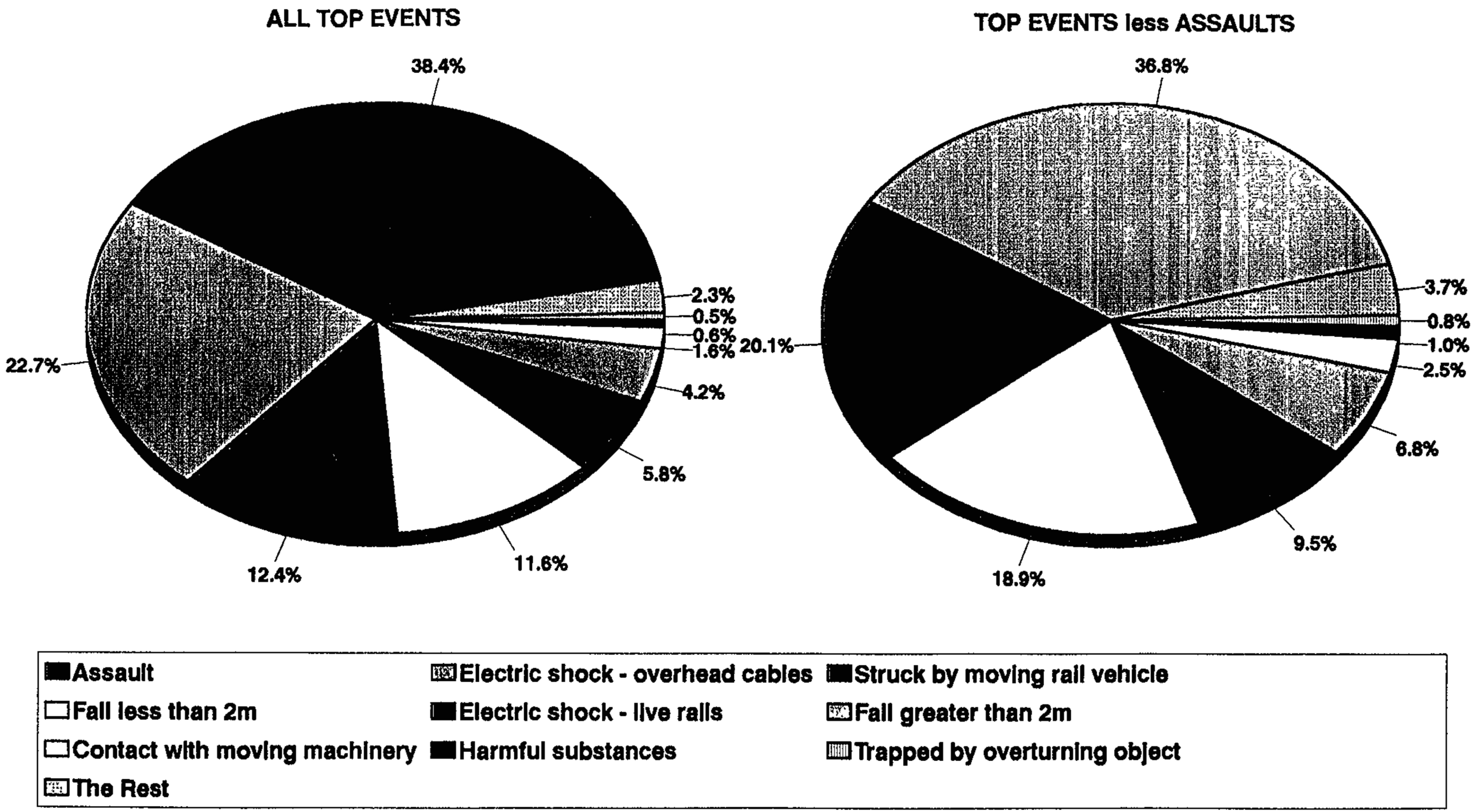
ALL LEVELS OF SEVERITY



APRIL 1993

STAFF ACCIDENT RISK ANALYSIS - RISK RANKING OF TOP EVENTS (2)

CRITICAL SEVERITIES ONLY



Note: These risks include only those levels of severity that could lead to an actual fatality

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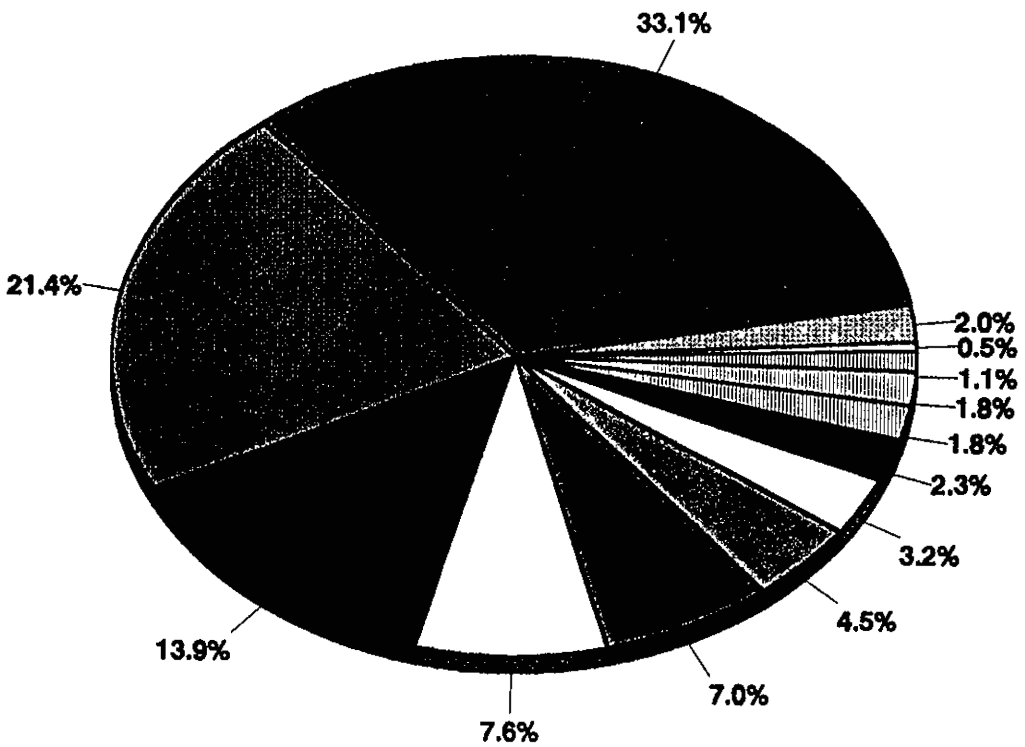
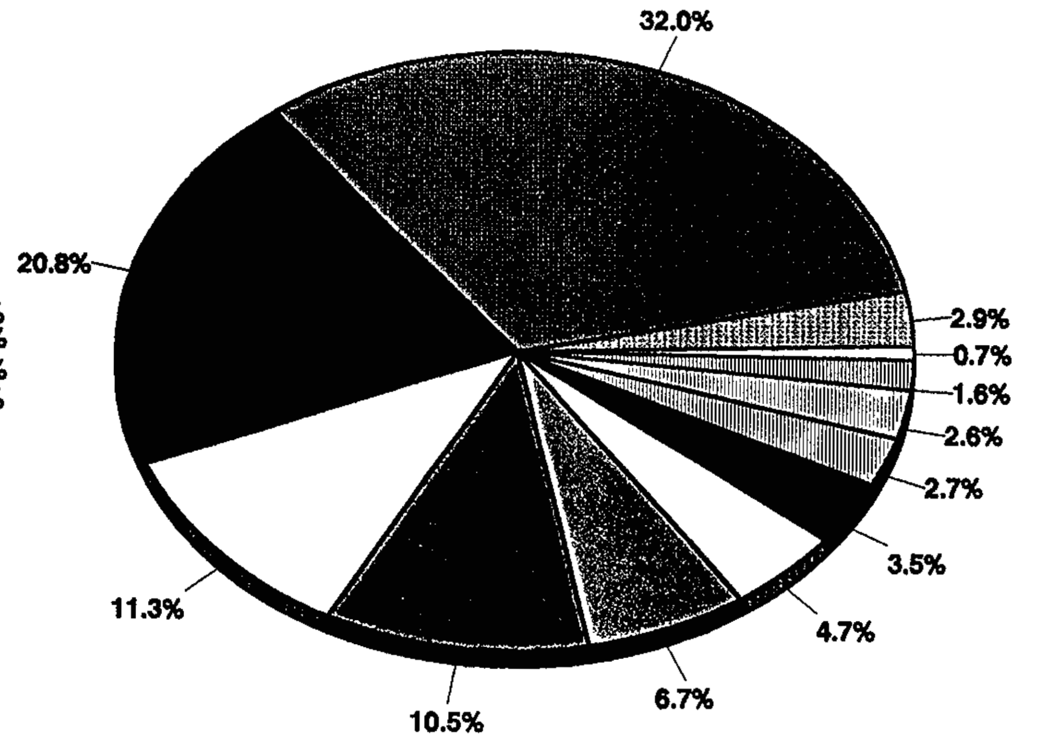
STAFF ACCIDENT RISK ANALYSIS - RISK RANKING OF TOP EVENTS (3)

ALL INJURY SEVERITIES ONLY

ALL TOP EVENTS



TOP EVENTS less ASSAULTS



Assault	Slip/trip/fall - same level	Manual handling - not rails	Struck by moving object - not rails
Fall less than 2m	Struck against fixed object	Fall from stationary rail vehicle	2 train collision in workshop/depot
Handling rails	Hand tools - unpowered	Collision hazard in workshop/depot	Fall greater than 2m
The Rest			

Note: These risks include only those levels of severity that will lead to an injury (LTI and non LTI) not a fatality

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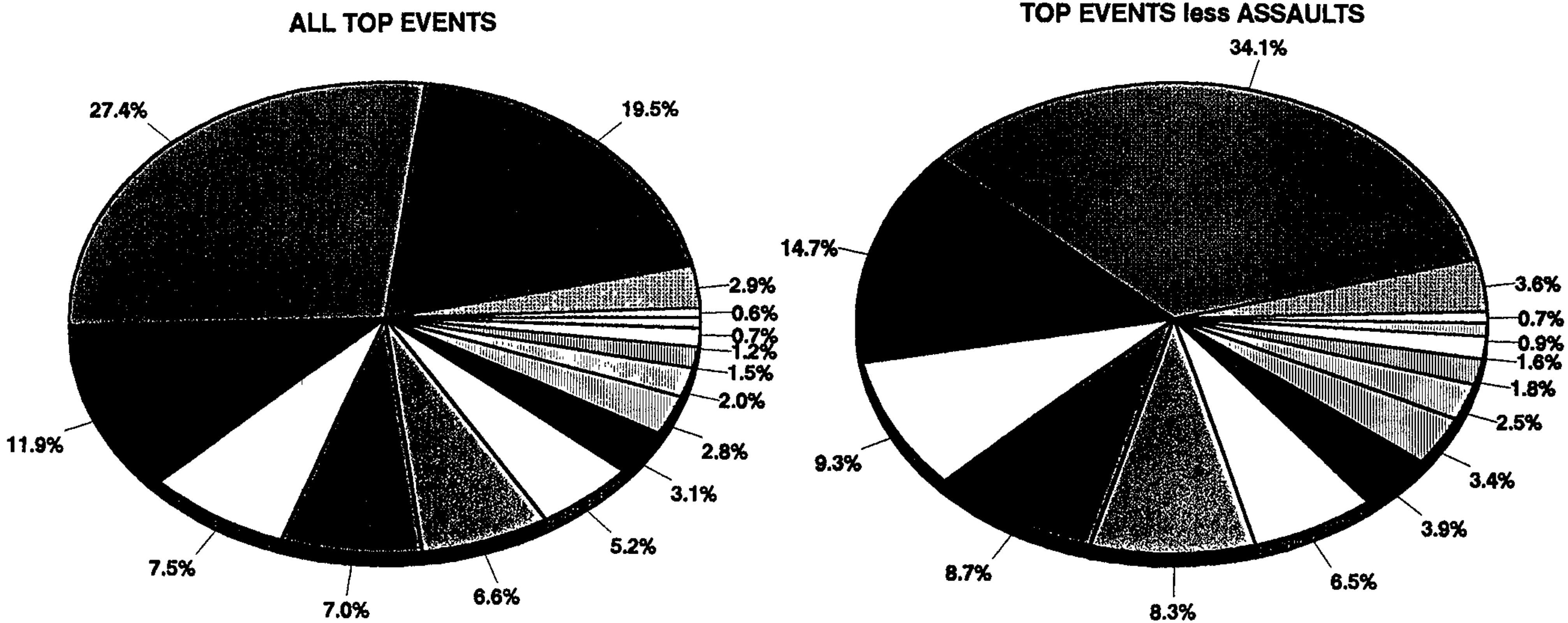
STAFF ACCIDENT RISK ANALYSIS - RISK RANKING OF TOP EVENTS (4)

MAJOR INJURY SEVERITIES ONLY



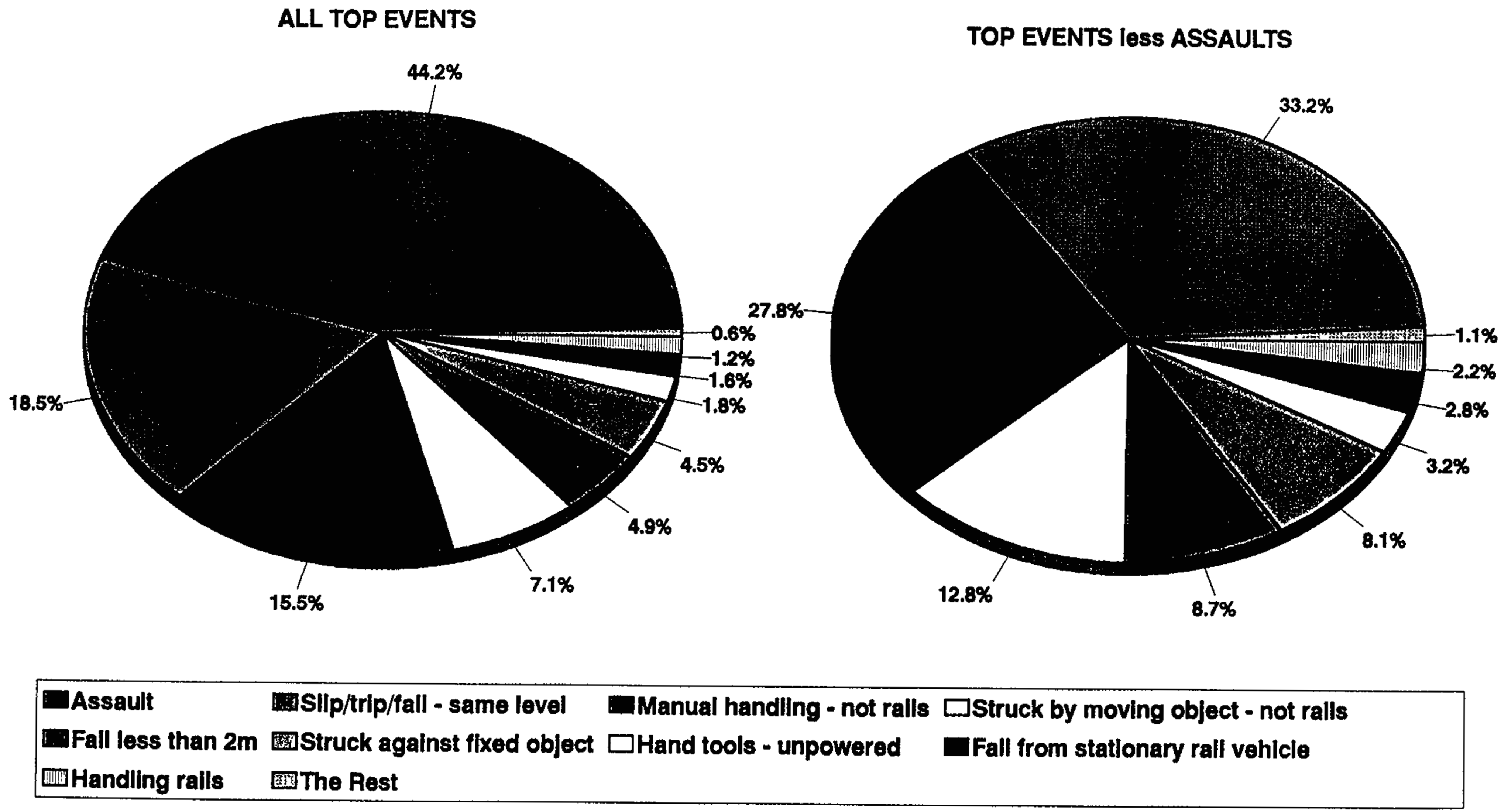
Assault	Slip/trip/fall - same level	Fall less than 2m
Struck by moving object - not rails	2 train collision in workshop/depot	Fall from stationary rail vehicle
Manual handling - not rails	Collision hazard in workshop/depot	Struck against fixed object
Handling rails	Hand tools - unpowered	Fall greater than 2m
Electric shock - live rails	Struck by moving rail vehicle	The Rest

Note: These risks include only those levels of severity that will lead to a major (lost-time) injury

APRIL 1993

STAFF ACCIDENT RISK ANALYSIS - RISK RANKING OF TOP EVENTS (5)

MINOR INJURY SEVERITIES ONLY

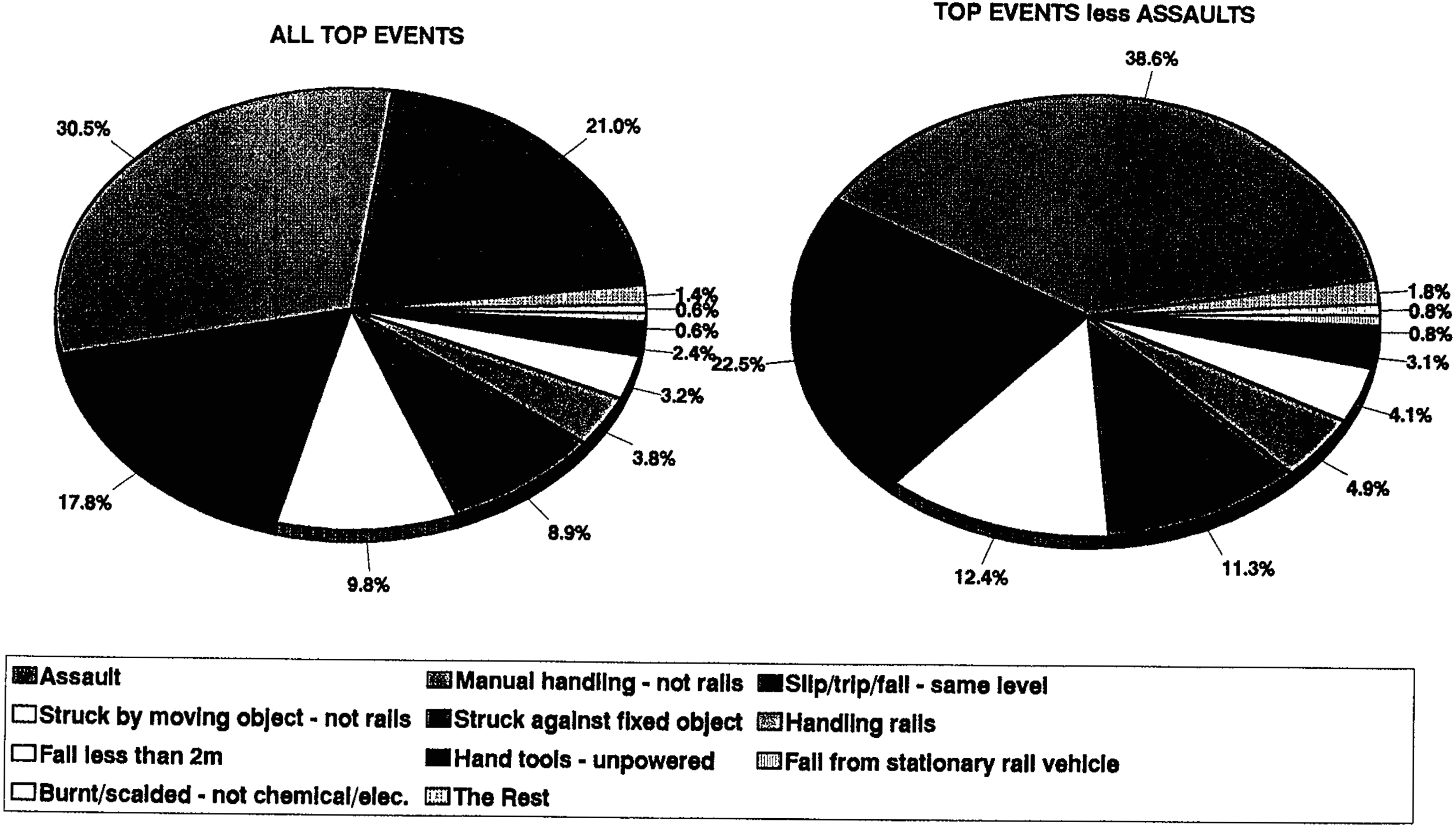


Note: These risks include only those levels of severity that will lead to a minor (lost-time) injury

APRIL 1993

STAFF ACCIDENT RISK ANALYSIS - RISK RANKING OF TOP EVENTS (6)

NON LOST-TIME INJURY SEVERITIES ONLY



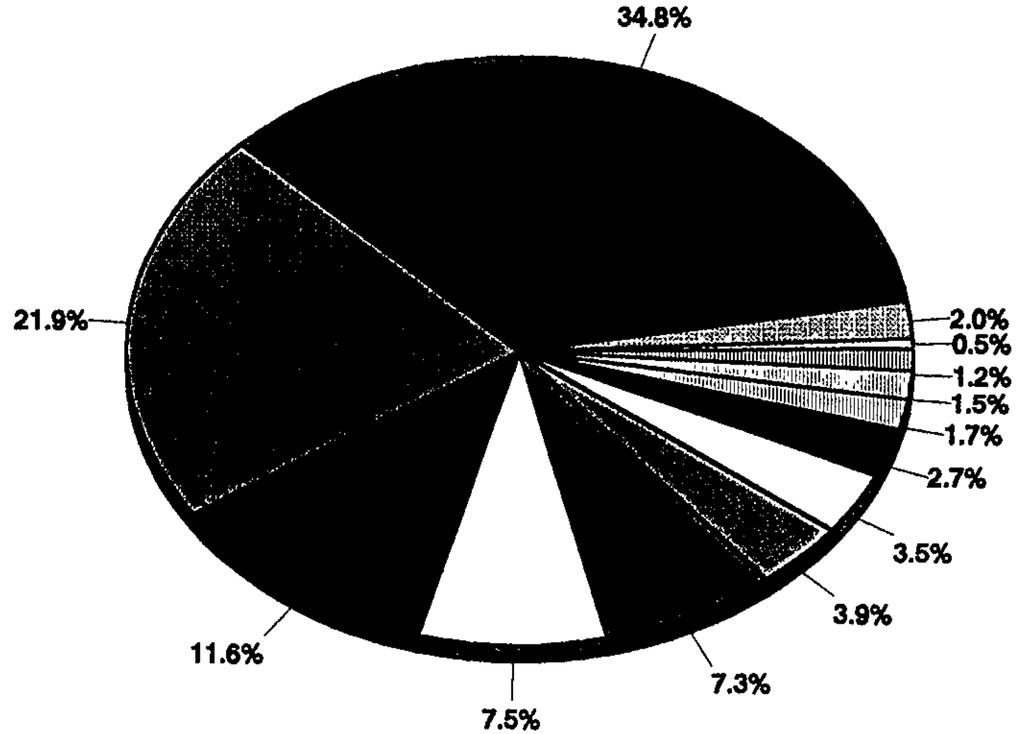
Note: These risks include only those levels of severity that will lead to a non lost-time injury

APRIL 1993

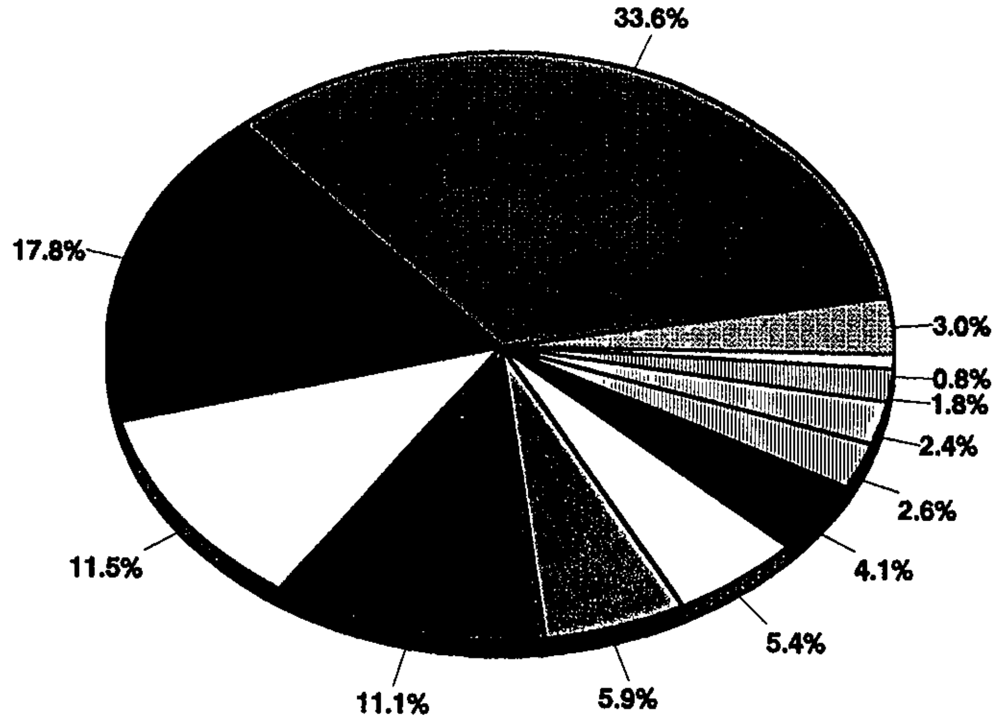
STAFF ACCIDENT RISK ANALYSIS - RISK RANKING OF TOP EVENTS (7)

LOST-TIME INJURY SEVERITIES ONLY

ALL TOP EVENTS



TOP EVENTS less ASSAULTS



Assault	Slip/trip/fall - same level	Manual handling - not rails
Fall less than 2m	Struck by moving object - not rails	Struck against fixed object
Fall from stationary rail vehicle	2 train collision in workshop/depot	Hand tools - unpowered
Handling rails	Collision hazard in workshop/depot	Fall greater than 2m
The Rest		

Note: These risks include all those levels of severity that lead to a lost-time injury

APRIL 1993

STAFF ACCIDENT RISK ANALYSIS - STRUCK BY TRAIN RISK RANKING

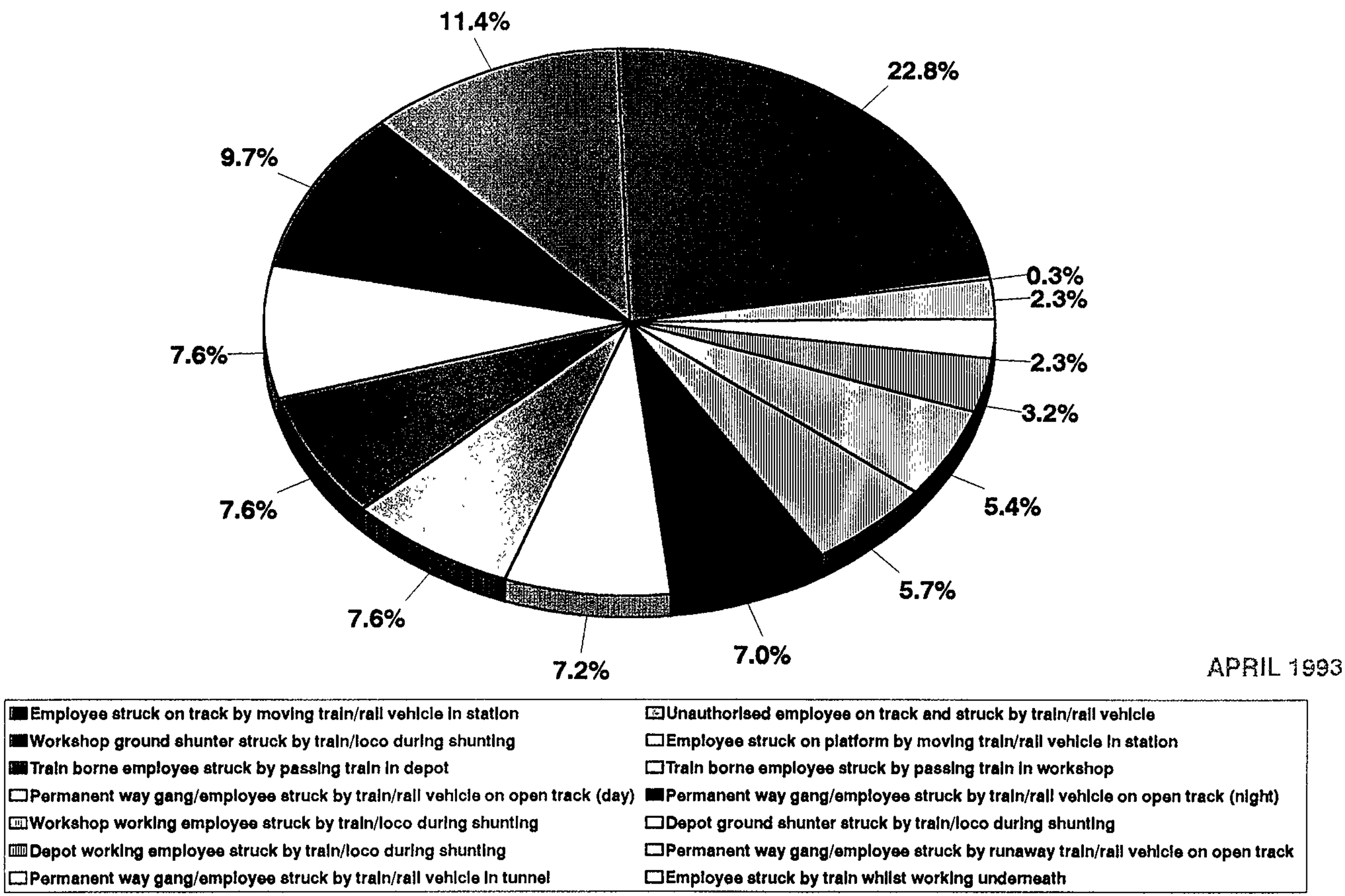


Table 6.3

Classification of Generic Tasks		Proposed Nominal Human Unreliability	5th - 95th Percentile Bounds
(A)	Totally unfamiliar, performed at speed with no real idea of likely consequences	0.55	0.35 - 0.97
(B)	Shift or restore system to a new original state on a single attempt without supervision or procedures	0.26	0.14 - 0.42
(C)	Complex task requiring high level of comprehension and skill	0.16	0.12 - 0.28
(D)	Fairly simple task performed rapidly or given scant attention.	0.09	0.06 - 0.13
(E)	Routine, highly-practised, rapid task involving relatively low level of skill	0.02	0.007 - 0.045
(F)	Restore or shift a system to original or new state following procedures, with some checking.	0.003	0.0008 - 0.007
(G)	Completely familiar, well-designed, highly practised, routine task, performed to highest possible standards by highly-motivated, highly-trained and experienced person, totally aware of implications of failure, with time to correct potential error, but without the benefit of significant job aids	0.0004	0.00008 - 0.009
(H)	Respond correctly to system command even when there is an augmented or automated supervisory system providing accurate interpretation of system state	0.00002	0.000006 - 0.0009
(M)	Miscellaneous task for which no description can be found	0.03	0.008 - 0.11

Table 6.4

	Error-Producing Conditions	Maximum predicted nominal amount by which unreliability might change going from "good" conditions to "bad"
1	Unfamiliarity with a situation which is potentially important but only occurs infrequently or is novel.	x 17
2.	A shortage of time for error detection and correction	x 11
3.	A low signal-noise ratio.	x 10
4.	A means of suppressing or over-riding information or features which are too easily accessible.	x 9
5.	No means of conveying spatial and functional information to operators in a form which they can readily assimilate.	x 8
6.	A mismatch between an operator's model of the world and that imagined by a designer.	x 8
7	No obvious means of reversing an unintended action.	x 8
8.	A channel capacity overload, particularly one caused by simultaneous presentation of non-redundant information.	x 6
9.	A need to unlearn a technique and apply one which requires the application of an opposing philosophy.	x 6
10.	The need to transfer specific knowledge to task without loss.	x 5.5
11.	Ambiguity in the required performance standards.	x 5

able 6.4 cont.

Error-Producing Conditions		Maximum predicted nominal amount by which unreliability might change going from "good" conditions to "bad"
12.	A mismatch between perceived and real risk (perception of consequences).	x 4
13.	Poor, ambiguous, or ill-matched system feedback	x 4
14	No clear direct and timely confirmation of an intended action from the portion of the systems over which control is to be exerted	x 4
15.	Operator inexperience (eg a newly-qualified tradesman, but not an "expert").	x 3
16.	An impoverished quality of information conveyed by procedures and person/person interaction (quality procedures).	x 3
17.	Little or no independent checking or testing of output.	x 3
18.	A conflict between immediate and long-term objectives.	x 2.5
19.	No delivery of information output for veracity checks.	x 2.5
20	A mismatch between the educational achievement level of an individual and the requirements of the task	x 2
21.	An incentive to use other more dangerous procedures.	x 2
22.	Little opportunity to exercise mind and body outside the immediate confines of a job.	x 1.8

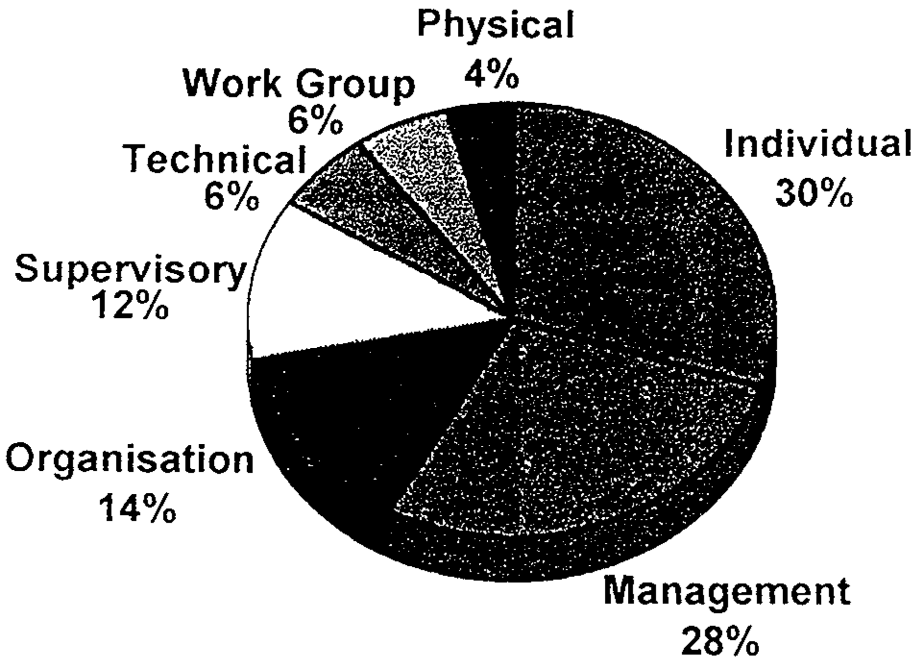
.able 6.4 cont.

	Error-Producing Conditions	Maximum predicted nominal amount by which unreliability might change going from "good" conditions to "bad"
23	Unreliable instrumentation (enough that it is noticed).	x 1.6
24	A need for absolute judgements which are beyond the capabilities or experience of an operator	x 1 6
25.	Unclear allocation of function and responsibility	x 1 6
26.	No obvious way to keep track of progress during an activity	x 1.4
27	A danger that finite physical capabilities will be exceeded.	x 1 4
28.	Little or no intrinsic meaning in a task	x 1.4
29.	High-level emotional stress (stress).	x 1 3
30.	Evidence of ill-health amongst operatives, especially fever.	x 1.2
31.	Low workforce morale (motivation)	x 1.2
32	Inconsistency of meaning of displays and procedures.	x 1.2
33.	A poor or hostile environment (below 75% of health or life-threatening severity).	x 1.15
34	Prolonged inactivity or highly repetitious cycling of low mental workload tasks	x 1.1 for 1st half hour x 1.05 for each hour thereafter

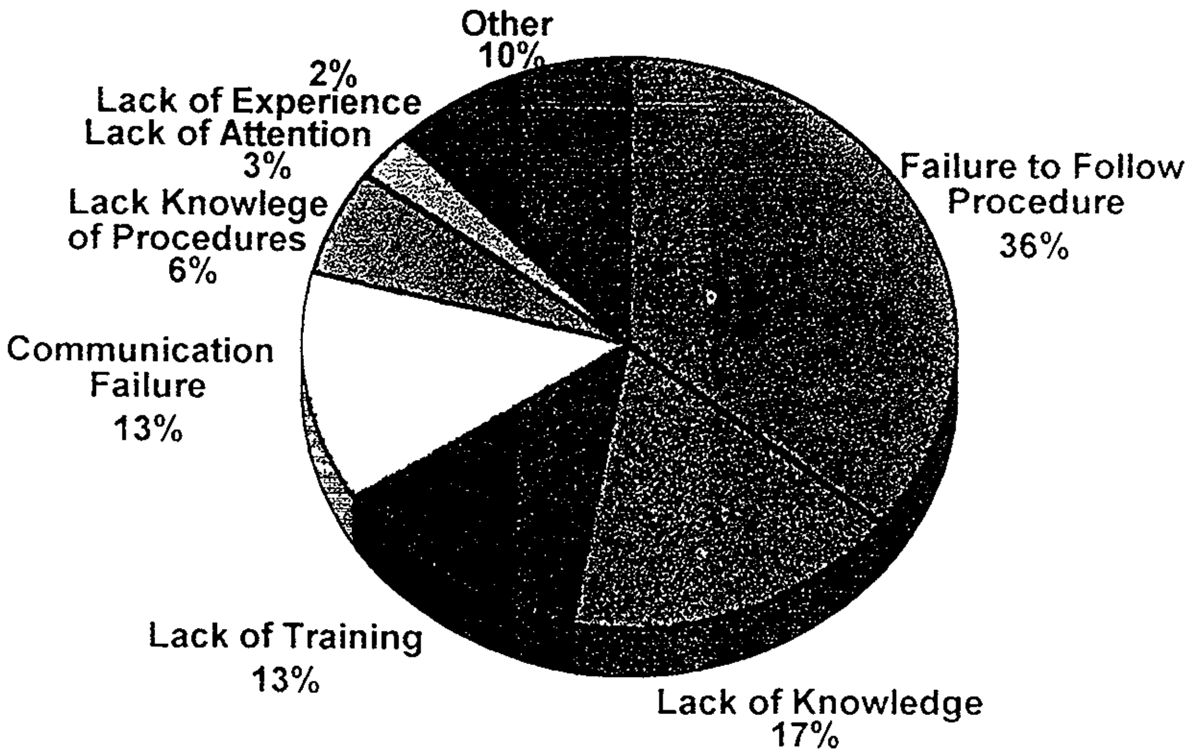
ible 6.4 cont.

Error-Producing Conditions	Maximum predicted nominal amount by which unreliability might change going from "good" conditions to "bad"
35. Disruption of normal work-sleep cycles	x 1.1
36. Task pacing caused by the intervention of others (time pressures).	x 1.06
37. Additional team members over and above those necessary to perform task normally and satisfactorily.	x 1.03 per additional man
38. Age of personnel performing perceptual tasks	x 1 02

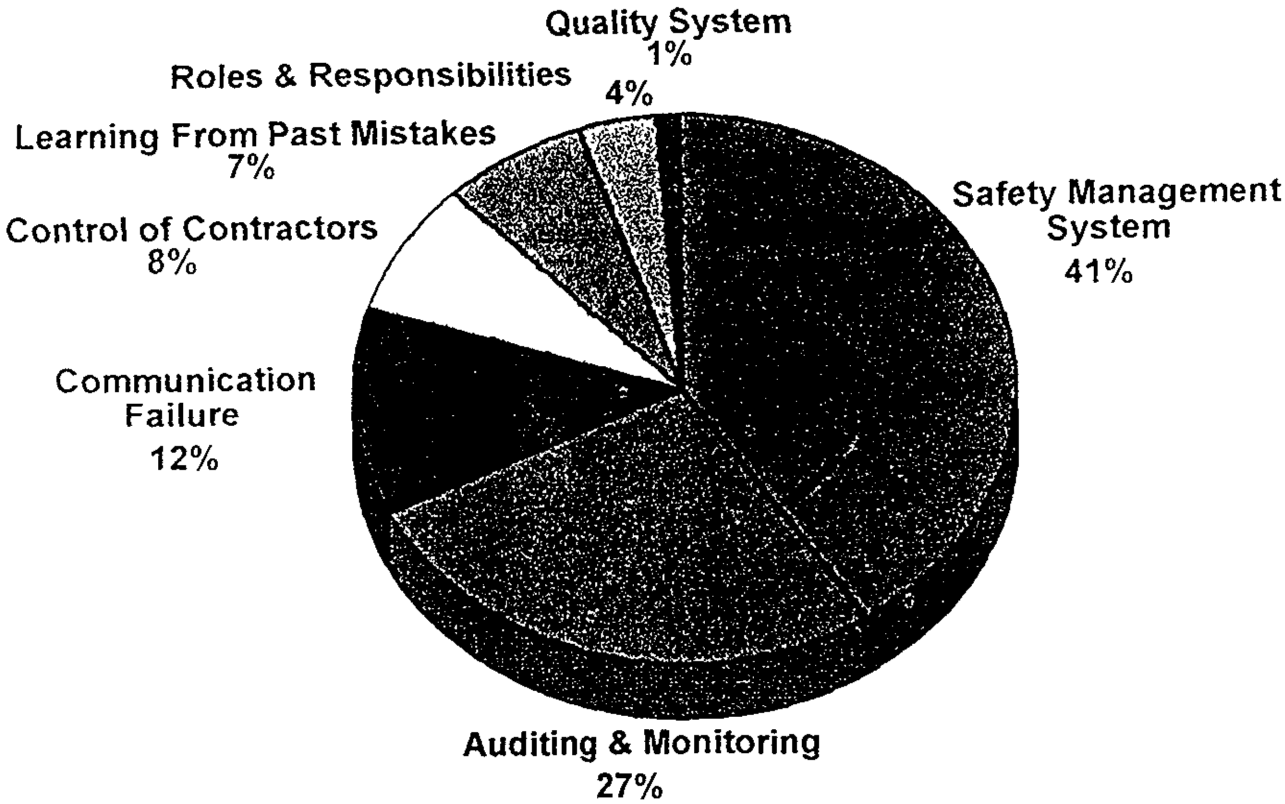
Percentage of Overall Causal Factors of Staff Accidents



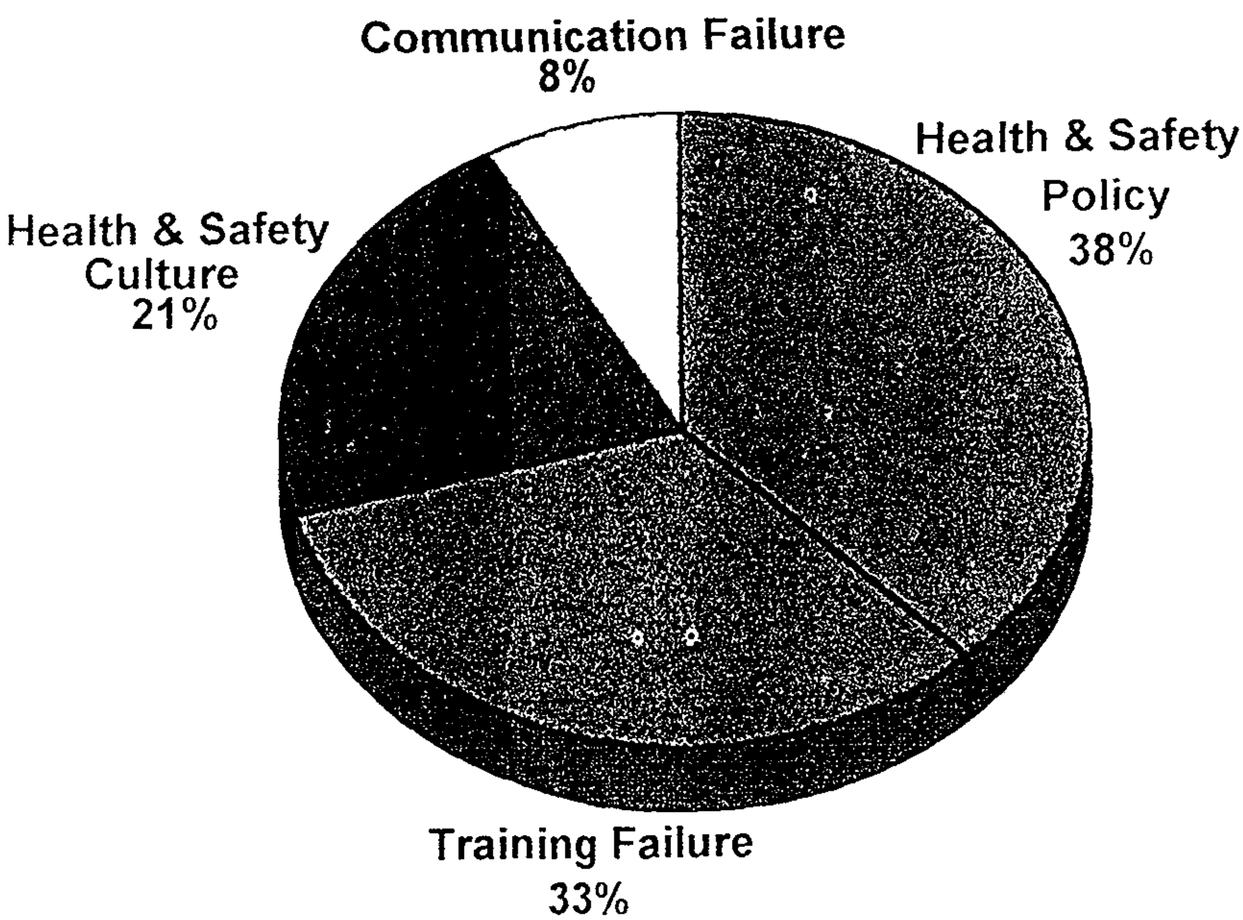
Individual Causal Factors



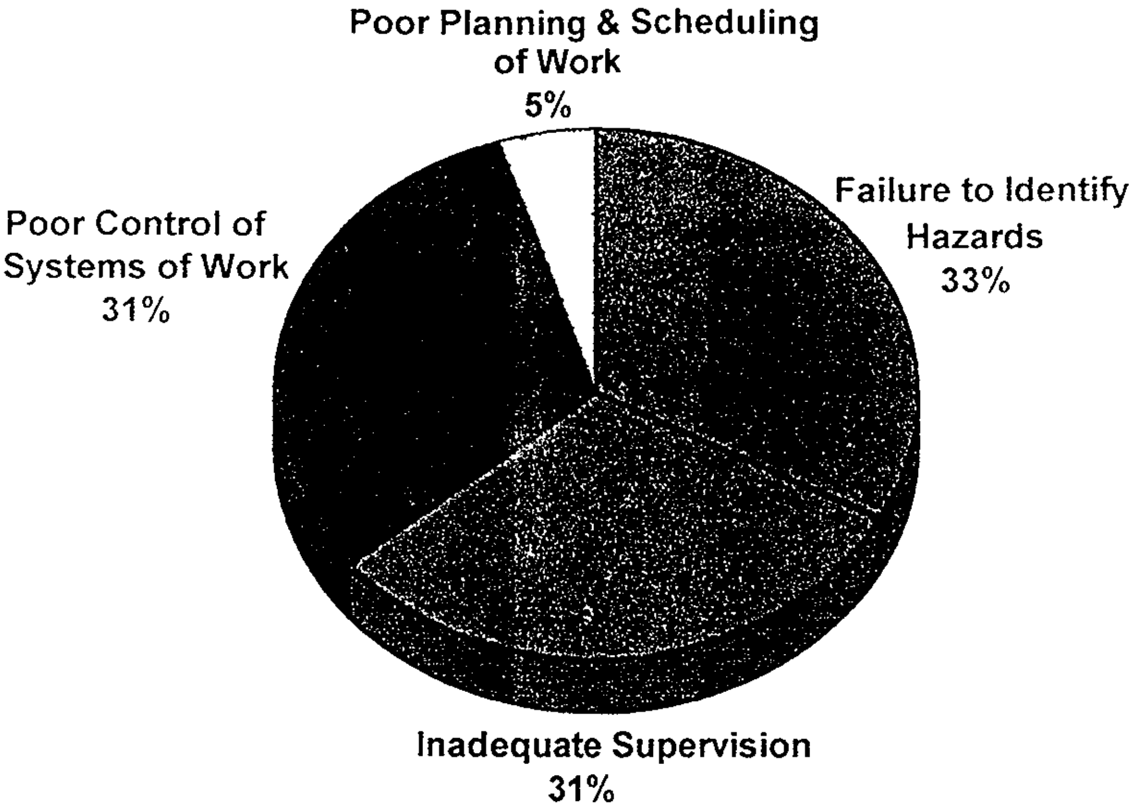
Management Systems Causal Factors



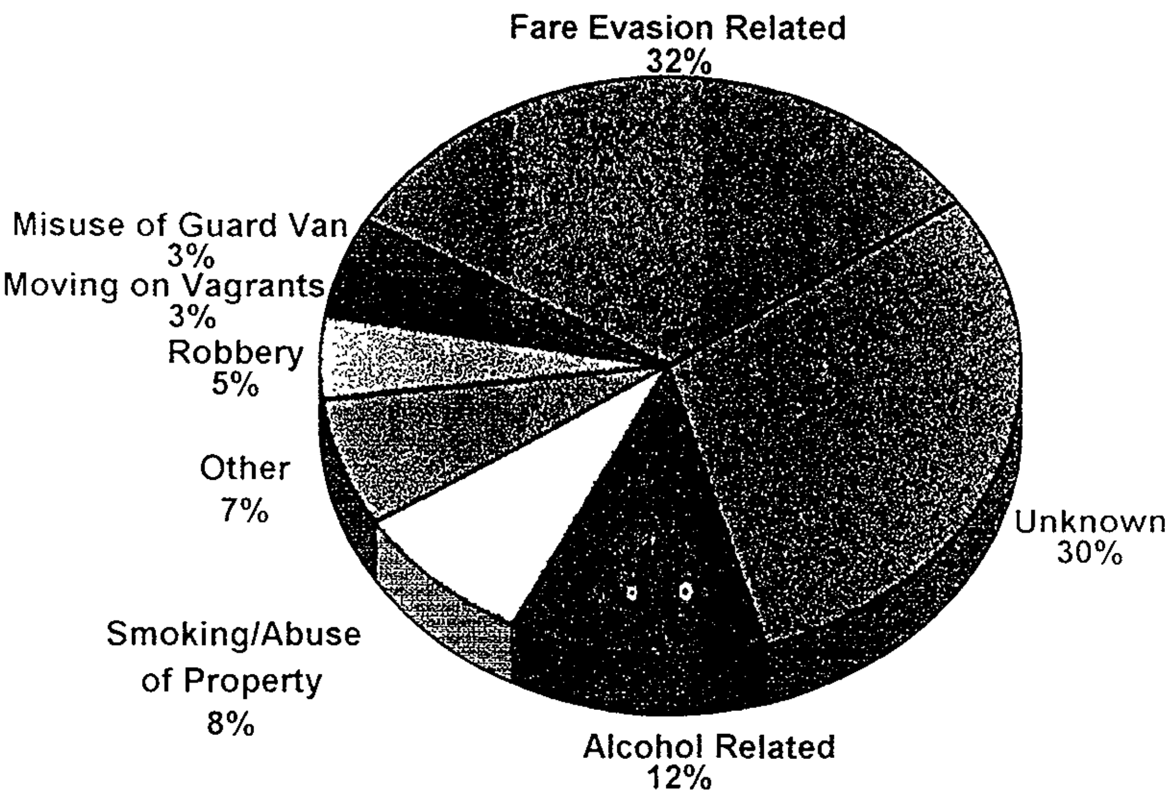
Organisational Causal Factors



Supervisory Causal Factors



Reason Given for Assault



1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9314

David Wharton-Street

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Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

WORKING HOURS RELATED WITH SAFETY

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BRITISH RAIL RESEARCH INTO WORKING TIME PATTERNS AND SAFETY

Abstract

British Rail (BR) has studied the relationship between working time patterns of their train drivers and safety. The Study examines event rates per million manhours worked for particular safety-related events. The main focus was signals passed at danger (SPADs), but operating incidents and personal accidents were also considered. Over 7500 events were examined, with exposure data of 50 million manhours. The results are interesting as, with the benefit of considerable quantities of evidence, the Study reveals no increase in safety risks when working up to 12 hour shifts, high levels of weekly hours, or long runs of consecutive shifts without a break. Safety risks were not found to be influenced by age, type of work, or variability in shift start time. Over the range of data examined, rest intervals between shifts and safety showed no clear relationship.

A clear pattern in the relationship between hour-into-shift and safety emerged. There is a peak in the risk of an event occurring in the 2nd to 4th hours of the shift, followed by a gradual decrease in risks up to the 12th hour. No data was available to examine any longer shifts. The existence of a daytime traffic effect (relating to passenger travelling patterns) complicates interpretation of the data, but does not explain the peak in risks found in the early part of shifts. Generally, the safety risks were found to be much less at night, but this was not so for the more serious events. No link, however, was then found between severity and hour-into-shift. Working high weekly hours was found to be associated with a higher proportion of the safer night and weekend work. Removing this shift mix effect revealed no underlying increase in risks as more hours were worked. There are some indications, however, that the risks may be greater for those working fewest weekly hours and on first returning to work after a period of time-off. Familiarisation may be outweighing fatigue effects over the ranges examined.

I Introduction

1 This report brings together the results and key supporting evidence from extensive statistical analysis of safety events (notably signals passed at danger) and train drivers working time patterns. It also reviews the methodology used and conclusions drawn, highlighting the caveats that are to be placed on the evaluation.

2 The full results for train drivers are available on request from BR's Safety Policy Unit in Report OYS003/1 (of BR's Operational Research unit). The main findings are to be published in Safety Science. Research continues into other groups of staff working in safety sensitive environments - engineering workshop staff, signalmen, trackside staff. It is also intended to investigate the causes of the more noteworthy results. Causation is only discussed in this report where the statistical analysis can provide guidance.

3 The Study's findings challenge many of the commonly held views in this field.

II Objectives

4 The objectives of the Study were threefold

4.1 To assess the safety risks of introducing more flexible working patterns for train drivers

In 1992 BR were contemplating a pay and productivity deal involving restructuring the drivers working hours contract. This would have involved negotiating the introduction of shorter and longer rostered shifts (outside the present range of 7 to 9 hours), as well as higher hours in individual weeks (balanced by more time off on other shifts and in other weeks). Such changes could potentially affect the safety of passengers and staff. In designing proposals, BR therefore needed

- to ensure any proposals, particularly for 12 hour shifts, posed no increased safety risk
- to have relevant factual safety evidence for use in negotiation with the Railway driver Unions.

4.2 To review the safety benefits of BR's working time "outer" limits, which were introduced in 1990 following the Clapham train accident, to monitor the working of very long hours

Four limits are in operation, which apply to all staff, not just drivers:

- maximum 12 hours work per shift
- minimum 12 hours rest interval between shifts
- maximum 72 hours work per week
- maximum 13 shifts in any 14 days.

At their time of introduction, there was no objective scientific evidence on which to base any limits. Limits constrain productivity and hence railway competitiveness. It is important therefore to test the safety benefits of the limits and obtain objective guidance as to whether they are correct or should be tightened or relaxed. Such information is especially relevant as the Health & Safety Commission (HSC) consider what working time limits are necessary for a privatised railway.

4.3 To increase understanding of the relationship between safety risks and working time arrangements in order to improve safety by changing working time arrangements

There are areas where academic and other opinion, and prospective UK regulations and European legislation suggest the need for constraints on working time to prevent fatigue endangering safety eg night working, cumulative weekly hours over long periods (eg the EC maximum 48 hour week). This Study sought to test such hypotheses from direct empirical evidence for a key group (train drivers). There are also other areas where the knowledge of a link to safety might help construct rosters or reorganise working arrangements to improve safety eg age, daily shift start variability, pattern and type of work.

III Scope

5 These objectives required many areas of working time to be explored, both separately, and, where data permitted, in combination with each other. Joint analysis of more than one working time factor simultaneously

(a) - tests whether conclusions represent genuine underlying effects and are not simply explained by another factor, eg the 2nd to 4th hour-into-shift peak in risk might be due to the hour-of-day result, which shows highest risks in the morning traffic peak, just after many drivers have started their shift; and

(b) increases the range of circumstances analysed eg looking at hour-into-shift effects at different hours-of-day, tested whether long shifts were as safe at night as in the day.

6 The full range of factors studied, separately or jointly, and definitions used are:

	Type of [1] work	Age [2]	Severity of [3] consequences	Hour of day
Hour-into-shift [4]	√	√	√	√
Hour-of-day[5]	√		√	
Consecutive shifts-into-spell [6]	√	√	√	√
Weekly hours [7]	√	√	√	√
Rest Periods between shifts				
Day of week				
Regularity of shift start time [8]				

1 Examined by categorising BR's 190 train depots according to Business ownership: Network South East depots (short trip stop start work with complex layouts and high traffic density); InterCity depots (high speed and long distance); Regional Railways depots (mixture of NSE type work and long distance cross country lower speed work); Freight depots (long haul and lower speed, "HGV" driving skills). Some depots will do other Business's work but it was not possible to reallocate such work.

2 Four age bands apply: drivers < 25 yrs; 25 to 44 yrs; 45 to 59 yrs; > 59 yrs at time of event.

3 Severity applies to SPAD consequences only. Four categories are used: 25 yard overruns with no damage/injury; 25 to 200 yard overruns with no damage/injury; over 200 yard overruns with no damage/injury; SPADs causing damage/injury (irrespective of overrun).

4 Hour-into-shift = 1st hr, 2nd hr etc. NB This is not the same as shift length eg 9 hr long shift, 10 hr long shift etc; such data would be biased since, when work stops after an incident, the length of shift that would otherwise have been worked is unknown.

5 Night shifts are taken as drivers starting on one day between 2100 and 2359 or finishing next day between 0001 and 0859. These periods were set by drivers actual booking-on and -off profile. Night-time (ie night hours) are hours worked between 2000 and 0659.

6 Consecutive shifts-into-spell = 1st shift, 2nd shift etc worked (for whatever reason) in a spell. NB This is not the same as number of consecutive shifts worked eg spell of 2 shifts, 3 shifts etc, for exactly the same reason as for hour-into-shift.

7 Weekly hours worked are analysed in two ways: weekly hours worked over last 7 days (including the day of the event), and average weekly hours worked over last 13 weeks. The 13 week average examines high cumulative hours over long periods, testing the EC max 48 hr week. At the time of this Study the EC reference period was 3 months (not 4 as it now is).

8 Regularity of shift start time: daily variability = change from previous day; previous week variability = average daily change over previous 8 days.

7 The analysis of these factors was naturally constrained by the actual working patterns and hence by drivers collective Agreements and the "outer" limits in operation. All hours and shifts worked (for whatever reason) were included eg training shifts as well as shifts spent driving. The range of experience where there was sufficient data for useful study were:

Factor	Range studied *
Hour-into-shift	1st to 12th hr
Hour-of-day	All 24 hours
Consecutive Shifts-into-spell	1st to 14th + shift
Weekly Hours : (one week)	1 to 70 + hrs
: (13 week average)	5 to 60 hrs
Rest periods between shifts	19 to 11 hrs and under
Day of week	All days of week
Regularity of shift start time	0 to 4 + hrs

* For nights, the full range was studied for hour-into-shift and hour-of-day, 1st to 7th + shifts for consecutive night shifts and 1 to 50 + hrs for weekly night hours.

8 This range of experience enabled analysis of risks

(a) up to BR's present "outer" limits but **not** beyond, except to a limited degree for consecutive shifts; and

(b) up to and beyond proposed EC limits, particularly for nights, average weekly hours and weekly rest.

The higher levels of working time are all being performed by drivers in overtime. Overtime is voluntary (although often rostered) and hence self-selection may influence the resultant risks. This aspect has not been specifically studied because of difficulty in obtaining comparative data.

IV Methodology

9 The Study assessed safety risks by examining event rates per million manhours worked of various safety-related events. The approach was to see whether the risk of an event occurring was higher in those shifts or parts of shifts corresponding to particular working practices. If one practice is inherently less safe than average, it would be expected to have a higher event rate. This approach involved the following steps:

(a) identifying relevant safety-related event data
(b) determining the exposure data
(c) calculating event rates (for relevant safety-related events)
(d) testing for statistical significance and genuine underlying effects.

(a) Safety-related event Data

10 The criteria for selecting events for study were first, safety-relevance; second, involving driver performance; third, statistical viability. An event was safety-relevant if it was either harmful in itself (personal accidents) or carried a risk of being harmful (SPADs, operating incidents). Driver performance was the mechanism by which working time patterns were transmitted into safety events. So safety-related events which the driver could not influence were excluded (eg SPADs caused by signal failure). Statistical viability covered both quantity of data being sufficient for statistically significant results to be possible, and acceptable quality of data. The safety-related events studied were:

10.1 Signals passed at danger (SPADs)

A SPAD occurs when a train (after advance warning) fails to halt at a red signal. A SPAD may or may not result in any damage or injury.

SPADs benefit from being a virtually distortion-free data source, since it is not the driver (but the signalman) who normally reports the SPAD. Large quantities of relevant data could be studied from BR's SPADMIS database: 5527 SPADs from 1985 to 1992 (after excluding any where a driver was not responsible). However, for some analyses (consecutive shifts, weekly hours, rest periods and regularity of shift start time), it was necessary also to match the individual with data held on the payroll to establish information about the particular working time pattern prior to the SPAD. Two full years payroll data from September 1990 to 1992 was used. These analyses could therefore only use SPAD data from the same period (1383 SPADs).

10.2 Operating Incidents

Operating incidents are where a driver fails to operate the train as required eg overruns platform, hits buffer. Damage or injury may or may not result.

967 driver-related incidents were used from BR's BRIMS database. In each case data was required from the payroll to obtain relevant working time details, hence the operating incidents analyses for all factors were restricted to 2 years 1990 - 1992 data.

10.3 Personal accidents

Personal accidents are those which drivers themselves incur whilst on duty eg slipping or tripping whilst in or out of cab. Such an accident may or may not result in lost time (ie days off injured).

947 personal accidents (due to driver-related causes) from 1990 to 1992 were used from the BRIMS database. As for operating incidents, data from the payroll was required. The main personal accidents excluded from study, not being driver-related, were those where the driver suffered shock from witnessing a suicide or major injury.

11 For each type of safety event, and for each of the working time factors studied, frequency distributions were produced eg number of SPADs in 1st hour, 2nd hour etc for studying hour-into-shift effects; number of personal accidents in 1st shift, 2nd shift in spell etc for studying consecutive shift effects.

12 Not all working time factors were examined for each of the three types of safety event. SPADs were analysed for all factors. Operating Incidents and Personal Accidents were analysed for the five factors relating to BR's "outer" limits (ie hour-into-shift, hour-of-day, consecutive shifts, weekly hours and rest periods).

(b) Exposure Data

13 To determine the safety risks one cannot look just at the frequency with which events occur. Naturally most events will occur with the most typical working patterns, when most drivers are at work. But the more unusual working patterns with very few events may in fact put the driver most at risk. To find out where the greatest risk lies, requires considering exposure to the risk in question and hence the rate at which such events occur.

14 The exposure data used, or 'population' base, for normalising the event data to calculate the rates, was drivers actual working hours (from booking-on to booking-off) on driving shifts. Thus hours spent on training and other non-driving shifts were excluded from the exposure data. This means that for any training shifts on say the 3rd shift in a run of consecutive shifts, booked hours from those training shifts do not contribute to the particular event rate calculated for that 3rd consecutive shift. The exposure data came from a complete 2 years payroll data from September 1990 to 1992, covering over 6 million driving shifts and 50 million manhours. It overcomes seasonal effects and provides detailed data on actual working time patterns.

15 Although other studies in this field have also used hours worked (GAO Rail Road Study of drivers in USA rail companies[1]; Van der Flier's study of SPAD's in Holland[2]; British Coal Study of hour-into-shift accident rates[3]), the choice of relevant exposure data is debateable. One option (for SPADs) was numbers of red signals encountered. But this is not a factor that can be varied by changes to working time arrangements. Another was the amount of actual **driving** time (as distinct from working time) ie the time the driver spends at the controls. In both cases no computerised accessible data was available. Further, they were not relevant to the prime way in which drivers' working time is regulated in BR's "outer" limits, and in HSC's proposed regulations on drivers hours of work for privatised railways ie hours actually on duty at work. It was possible, however, to use driving time to validate the selected exposure data (see Annex A).

16 For each of the working time factors studied, frequency distributions of time worked were produced eg number of million manhours in 1st hour, 2nd hour etc for studying hour-into-shift effects; number of million manhours on 1st shift, 2nd shift in spell etc for studying consecutive shift effects.

(c) Calculate Safety-related event rates

17 The event rate is simply the ratio of the two distributions at steps 9(a) and 9(b) above, for each safety-related event and each factor studied eg SPAD rate per million drivers hours (MDH), operating incident rate per MDH, personal accident rate per MDH, for each hour-into-shift, hour-of-day, weekly hours etc. So SPADs in the 12th hour, divided by million driver hours in the 12th hour, gives SPAD rate per MDH for 12th hour.

(d) Testing for statistical significance and genuine underlying effects

18 In order to draw conclusions about safety risks from the results, it is necessary to be sure the event rates eg for SPAD/MDH in 3rd and 4th consecutive shifts, are genuinely different. This was dealt with by:

(1) removing the effects of random fluctuations; and

(2) testing for genuine underlying effects ie to eliminate possible "artifacts" in the result.

19 Standard statistical tests were used to test whether variations in the event rates were just random fluctuations or statistically significant results. This is particularly important when studying the risks of BR's "outer" limits which are at the extremes of BR's experience where little data exists. This was done by assuming a Poisson distribution of event data and calculating the bounds, or confidence limits, within which one is 95% confident the "true" rate will lie. So for any 20 points on a graph, one point in 20 can be expected to lie outside the confidence limits.

20 The confidence limits remove the effects of random (or chance) fluctuations by giving ranges within which the "true" rate lies. Comparing one range with another gives an indication of where an underlying trend exists.

21 To eliminate possible "artifacts" in the data it is necessary to remove possible causes of the result eg if the hour-into-shift results were caused by the hour-of-day result, then the hour-into-shift result would not be demonstrating a genuine underlying effect. This required joint analysis of as many factors as possible (as was noted in the scope of this Study, at paragraph 5(a)) eg hour-into-shift by hour-of-day, hour-into-shift by age. Joint analysis was done by:

(a) performing the analyses for different subgroups in a second factor eg hour-into-shift was studied by itself and then again for each of the 4 age bands, for each of the 4 types of work, and for each of the 4 severity categories

(b) applying more sophisticated statistical techniques (multivariate analyses) to isolate 2 and in one case 3 factors eg studying hour-into-shift by hour-of-day; weekly hours worked by hour-of-day and hour-into-shift.

This enables the results to have been tested against as many as possible of the hypotheses which might be put forward to explain the findings.

V Validation

22 Extensive checks on both the safety-related event data and exposure data were conducted. These are discussed at Annex A.

VI Results and Supporting Evidence

23 The following section states the main findings and provides the key supporting evidence for each result. Graphs of the five key results only are attached. The conclusions drawn rely upon the statistically significant results (unless otherwise stated). The prime guidance was sought from SPADs where data integrity and quantity was greatest.

Shift Length (See Graph 1, Annex B)

24 Evidence does not suggest safety risks increase with working long hours (up to 12) in a shift. On the contrary, the later hours are less risky than the earlier hours in the shift. There is no evidence to suggest an apparent safety benefit from current BR "outer" limit (of 12 hr shift).

24.1 The evidence shows a clear pattern in the event rate by hour-into-shift for all three safety-related events examined. Safety risks/MDH

- peak in the early part (2nd to 4th hour)
- fall to average level (middle of shift)
- reduce thereafter, levelling out in later 8th to 12th hours (but less so for Operating Incidents and Personal Accidents where 10th to 12th hr not statistically significant)
- show no upward trend as the data runs out at 12th hour in the shift.

24.2 For SPADs, drivers are more than twice as likely to have a SPAD in their 2nd to 4th hour ie in their 'personal peak', as in their 8th to 12th hour.

24.3 Neither particular age bands nor type of work nor the most severe events showed any increased risk with later hours in shift (see paragraph 26).

25 Evidence shows the riskiest part of the shift is the 2nd to 4th hour and this 'personal' peak is not explained by the existence of the morning/evening passenger traffic peak effects or any other identified factor.

25.1 Removing the hour-of-day, and hence traffic effects, from the hour-into-shift SPAD results hardly altered the pattern of hour-into-shift risks. It only marginally depressed the 'personal' peak and marginally increased the later hours, leaving the 2nd - 4th hour rate still twice the level of 8th to 12th.

25.2 Neither did particular age bands, types of work, nor severity of consequences show any different pattern of risks (see paragraph 26).

25.3 When non-driving hours were removed from the hours worked (ie start up time, end of shift time, mealbreaks and other dead time), the peak SPAD risk was still the early part of shift (but the peak moved from 3rd to 4th hour) with later hours still lower risk. The 4th hour risk (73.2 SPAD/MDH) became slightly less than twice the later hours risk (41.3 SPAD/MDH).

25.4 It has not been possible to test for any relationship with mealbreaks.

26 **Pattern of safety risks associated with shift length is not influenced by type of work, age or severity of consequences.**

26.1 SPAD/MDH for each type of work studied shows the same pattern across the shift ie the later hours (8th onwards) on Network SouthEast, Regional Railways, InterCity and Freight depot work all show lower SPAD rates than for the earlier hours (3rd hour peak). The differences are statistically significant, except for InterCity.

26.2 SPAD/MDH for each age band studied shows broadly the same pattern across the shift ie greatest risks in earlier hours. However, not all the results are statistically significant, particularly for under 25 years and the 12th hour figures across all age bands.

26.3 SPAD/MDH for each severity category studied shows the same pattern across the shift ie greatest risks in earlier hours. In particular, the most severe SPADs (those resulting in damage or injury) exhibited a clear peak in 2nd to 4th hour, reducing thereafter. Not all the results for later hours are statistically significant.

27 **Evidence does not suggest working long shifts (over 9 hrs) going into the passenger traffic peaks increases safety risks.**

27.1 Where the 9th to 12th hour-into-shift coincides with the morning and evening passenger traffic peaks, which are the riskiest times of day, the safety risks (in 9th to 12th hours) are on an increasing trend, but at a level below the average rate at the traffic peak. So even at the riskiest hour-of-day, the later hours present no greater risk (and possibly less).

27.2 For example, those booking-on between 2200 and 2359 have their 9th to 12th hours in the morning traffic peak and a SPAD/MDH of 30.4 in those hours, compared with the average rate for the morning traffic peak of 35.8. This is even more marked for the evening traffic peak: those booking-on between 0800 and 0959 have their 8th to 11th hours in the evening traffic peak and a SPAD/MDH of 17.4 in those hours compared with the average rate for the evening traffic peak of 29.1.

28 **Evidence does not suggest higher safety risks when working long shifts (over 9 hrs) at night-time. There is no apparent safety benefit from the proposed EC Directive Working Time limit on nights (of 8 hrs).**

28.1 Removing the hour-of-day and hence night-time traffic effects from the hour-into-shift SPAD results hardly altered the pattern of hour-into-shift risks (as 25.1 notes). The very marginal increase in the later hours still left the risks in such hours only half those of the 'personal' peak.

28.2 Where the 9th to 12th hour-into-shift occurs at night-time (ie 2000 to 0659), the safety risk (in 9th to 12th hours) was **below** the average rate for night-time. So even at night the later hours in the shift present no greater risk (and possibly less).

28.3 For example, those booking-on between 1400 and 1559 have their 9th to 12th hour occurring after 2200 hours and a SPAD/MDH of 11.8 in those hours compared with the average rate for night-time of 16.2. Those booking-on between 1800 and 1959 whose 9th to 12th hours occur between 0200 and 0459, have a SPAD/MDH of 11.4 in those hours compared with the average rate for night-time of 16.2.

Nights (See Graph 2, Annex B)

29 Evidence does not suggest night-time risks being greater than daytime. On the contrary, night-time generally has lower safety risks than daytime.

29.1 The evidence shows a clear pattern in the event rate over the 24 hour day for SPADs and Operating Incidents. Safety risks/MDH

- peak in the morning passenger traffic peak (0700 to 0900)
- reduce to the average level (midday)
- rise again to second lower peak in evening traffic peak (1600 to 1800)
- reduce thereafter, remaining consistently and significantly lower from 2000 onwards throughout the night until sharp rise (at 0600).

Personal Accidents were not found to be related to hour-of-day, with possible exception of slightly less risk in early hours of morning (0300).

29.2 Drivers are more than twice as likely to have a SPAD in morning passenger traffic peak as in the early hours of morning.

29.3 Removing the hour-into-shift effects from hour-of-day SPAD results hardly altered the pattern of hour-of-day risks, which seem strongly influenced by the traffic levels. It only slightly reduced the morning traffic peak, leaving SPAD/MDH in the morning traffic peak still more than twice the level in the early hours of morning.

30 Pattern of safety risks associated with hour-of-day is not influenced by type of work.

30.1 SPAD/MDH for each type of work shows a broadly similar pattern across the 24 hours, ie the night-time risks less than daytime. This was more so for Network SouthEast and Regional Railways depot work than Freight and InterCity depots. The differences were not all statistically significant for InterCity and Freight.

31 **There is some evidence suggesting that the risk of a more severe safety event is higher at night-time, but there was no identifiable link to hour-into-shift fatigue. Freight and light running constitute the majority of severe events, but for both day and night.**

31.1 As degree of severity increased, the SPAD/MDH profile altered across the 24 hours. The more severe SPADs ie those resulting in damage or injury, showed:

- no peak in risks at the morning and evening traffic peaks
- no lower risk at night-time, with possibly a higher night-time than daytime risk (peaking at midnight).

31.2 Although freight and light running locos (locos not hauling any rolling stock) account for only one third (34%) of all SPADs, they account for 62% of all the more severe SPADs. However the 62% varies little by hour-of-day ie it is no worse at night when more freight than passenger trains are running.

31.3 All types of train, including passenger, have a higher ratio of severe to non-severe SPADs during the night than day.

31.4 Studying just the more severe SPADs (ie those resulting in damage or injury) around midnight (2300 to 0200) shows most still occur in the drivers' early hours-into-shift, ie in their 'personal' peak, and not in their later hours. Thus hour-into-shift fatigue is not a contributory factor. This does not however rule out body clock fatigue, but these issues arise from the railway traffic pattern not from decisions about how to organise working time to service that pattern of operations.

31.5 Further work will be done to test for any link between the more severe SPADs and variability of shift start time (where the US Railroad Study found a link).

32 **Evidence does not suggest a cumulative increase in safety risks with greater amounts of night working (over the week).**

32.1 SPAD/MDH for those working consecutive night shifts shows no increase with higher numbers of night shifts worked consecutively (up to 7+, when the data runs out).

32.2 SPAD/MDH for those working night shifts over the last seven days (but not necessarily consecutively) shows no increase with higher amounts of hours of night shifts worked (up to 50+, when the data runs out).

Consecutive Shifts (See Graph 3, Annex B)

33 **Evidence does not suggest working high numbers of consecutive shifts (up to 14+) without a break increases safety risks. There is no evidence to suggest an apparent safety benefit from the current BR "outer" limit (of 13 shifts in any 14 days) or the proposed EC Working Time Limit of weekly rest (of 35 hrs, ie 1 day off per week).**

33.1 The evidence shows a generally similar pattern in the event rate by consecutive shifts-into-spell for all three safety-related events examined. The pattern of safety risks is weaker than for hour-into-shift and hour-of-day, but shows:

- a higher risk for the first shift back after a break

- generally higher risks for the first five consecutive shifts than thereafter (although not always statistically significantly higher)

- no upward turn as the data runs out at 14th and over consecutive shift.

33.2 Further work will be done to test whether the risks on first shift back are related to length of time absent.

34 Pattern of safety risks associated with consecutive shifts is not influenced by type of work, age, or severity of consequences.

34.1 The SPAD/MDH for each type of work studied, each age band studied and each severity category studied contained insufficient data in all cases to identify statistically significant trends. However, the results were consistent with the overall result with no different trend emerging of consecutive shifts.

Weekly Hours (See Graphs 4 and 5, Annex B)

35 Evidence does not suggest working high numbers of weekly hours (up to 70+) increases safety risks. There is no evidence to suggest an apparent safety benefit from the current BR "outer" limits (of 72 hrs per week).

35.1 The evidence shows a broadly consistent pattern in the event rate by hours worked in last seven days for all three safety-related events examined. Safety risks/MDH

- are highest (but not statistically significantly higher) for those working fewest weekly hours (under 10 per week)

- stay at average level for those working up to 50 hrs per week

- reduce up to 70 hrs (that reduction being explained by shift mix effects: see 35.2 below).

35.2 Taking the shift mix into account shows a steadily increasing proportion of time worked at the lower risk times, ie nights and weekends, as more weekly hours are worked. Work in these periods increases from 5% (for drivers working 30 to 39 hrs per week) to 78% (over 70 hrs per week). Removing this effect from the weekly hours results removed the apparent reduction in risks over 50 hours per week and did not reveal any underlying increase as higher hours were worked.

36 **Pattern of safety risks associated with weekly hours was not influenced by type of work, age or severity.**

36.1 SPAD/MDH for each type of work shows broadly the same pattern across the week ie the higher hours (over 50 per week) have lower risks. The reduction is likely to be due to the shift mix findings noted at 35.2.

36.2 SPAD/MDH for each age band shows the same general pattern across the week ie a slightly downward trend in risks as hours increase. This applied equally to the age band (25 to 44) working highest weekly hours. The reduction is likely to be due to the shift mix effects. Not all the results were statistically significant.

36.3 SPAD/MDH for each severity categories shows the same general pattern across the week, and consistent with the overall result for longer hours worked in the last week to correspond with lower risks. Shift mix effects are likely to explain the lower risks. Not all the results were statistically significant.

37 **Evidence does not suggest any cumulative increase in safety risks when working high weekly hours (up to 60), when averaged over a 13 week period. There is therefore no apparent safety benefit from the proposed EC Working Time limit of a maximum 48 hour average week.**

37.1 The evidence shows a pattern in SPAD/MDH very similar to hours worked over last seven days result: a trend for higher average weekly hours to correspond to lower SPAD rate.

37.2 The data runs out beyond the 48 hr limit (at 60 hours), with the trend in risk continuing downwards. Although shift mix effects were not positively examined, an initial investigation suggested, as with the single week result (noted at 35.2), the downward trend may be due to the shift mix effect. Removing that effect did not reveal an upward trend.

Rest Periods (See Graph 6, Annex B)

38 **No consistent evidence of any clear pattern relating length of rest periods between shifts and safety risks. There is no evidence to suggest an apparent safety benefit from the current BR "outer" limit (of 12 hrs).**

38.1 The evidence shows no clear pattern in the event rate by rest periods for the three safety-related events examined. Safety risks/MDH

- showed no trend at all across the rest period examined for Personal Accidents and Operating Incidents: it neither increased with periods of 12 hrs and below 12 hrs, nor reduced for longer periods (up to 19 hrs)

- showed a slight increase for SPADs from the current norm (of 16 hrs rest between shifts) for both shorter and longer rest periods. But only 16 hrs rest was a statistically significant result.

Day of Week

39 Saturday and Sunday working involve lower safety risks than Monday to Friday.

39.1 The evidence shows a clear pattern in SPAD/MDH by day of week: Saturday and Sunday have significantly lower risks. This is consistent with the hour-of-day results which showed the off-peak periods the safest periods.

Regularity of shift start time

40 Evidence does not suggest any increased safety risk with irregular working (ie large daily or weekly variability in shift start time), or with regular working (identical daily start times).

40.1 Large daily variability in shift start times was not common. Only 20% of shifts varied from one day to the next by more than 2 hrs (either way), of which just less than half were by more than ± 4 hrs. Those with greatest variability showed a slight reduction in risks. Although not specifically tested, this reduction is likely to be because of hour-of-day effects leading to such shifts being worked at safer times ie at night.

40.2 Daily regularity in shift start times accounted for the majority of shifts. 64% varied by less than ± an hour (of which over half had no change). No increase in risk was associated with these groups.

40.3 The evidence on previous week average daily variability in start time was similar to daily variability. Again, no increase in risks, if anything a decrease at both extremes (for no variability and ± 4 hrs variability). Again, the times when such shifts are worked may explain the reduction in risk.

Type of Work

41 Whilst type of work was not found to influence the risks associated with various working time patterns, the evidence shows different types of work have significantly different absolute levels of risks.

41.1 SPAD/MDH was highest for InterCity depot work 30.0, joint lowest for Network SouthEast and Freight depot work 22.0 with Regional Railways depot work 27.0 in between. Such differences can only partly be explained by the differences in working patterns (eg Network SouthEast typically work longer hours, which were found to be lower risk).

Age

42 Not only was age found not to influence the risks associated with various working time patterns, the evidence also shows different age bands have very similar absolute levels of risk.

42.1 SPAD/MDH were very similar for all age bands examined. Although drivers under 25 had a higher rate lack of data meant the result was not significant.

VII CONCLUSIONS

43 This Study into train drivers working time patterns and safety has important results for managing safety. There are messages which run counter to much current thinking in this field, as well as suggesting new aspects to be addressed. An extensive range of working time factors are studied individually and, where possible, jointly. The results are based on substantial quantities of data.

44 The Study shows how the safety effects associated with working time arrangements can be objectively assessed. The method has potential to improve safety, monitor effects of existing working time arrangements, and ensure railway competitiveness is not constrained by limits on working time which are unjustified on grounds of safety.

45 The Study's initial objective was to assess any increased safety risks associated with the proposed restructuring of the drivers working time contract, particularly longer (but fewer) shifts. The Study shows none were evident and the findings were used to achieve full safety validation of the proposal in January 1993.

46 The findings also show no evidence of safety benefit for drivers from BR's specific "outer" limits on working time, some of which are similar to those proposed in a regulatory and legislative context. The Study finds

(a) no evidence that safety risks increase with working long hours and hence no apparent safety justification for limits of 12 hrs per shift, 72 hrs per week or 13 shifts in any 14 days; no clear relationship between safety risks and rest intervals between shifts is found and hence no apparent safety justification for the 12 hrs minimum rest interval;

(b) no safety benefit from introducing tighter "outer" limits in these working time areas. Moreover, there could be a safety disbenefit where the risks relating to the present limits are lower than the risks relating to the mix of hours/shifts resulting from introducing a tighter limit.

(c) minimal direct evidence on the likely effects of relaxing the BR limits is available. This is because the range of data available for study runs out at or just beyond BR's limits. However, no upward trend in risks just within the range of evidence emerges from BR's data. British Coal evidence was able to explore a longer period of hour-into-shift data and saw an upturn in risks at the 14th hour-into-shift.

47 The Study also shows no apparent safety benefit from introducing constraints in other working time areas, where both UK Regulations and EC legislation are under consideration:

(a) no evidence that the cumulative effects of working high weekly hours over a period increases safety risks. This applies not just up to an average 48 hour week (averaged over 3 months) but up to an average of 60 hours, the point at which the data runs out;

(b) no higher safety risks at night associated with working time patterns and hence no safety justification for restricting the length of night shifts (to 8 hrs). Again a safety disbenefit might arise from say replacing two 12 hour shifts with three 8 hour shifts;

(c) no safety benefit associated with weekly rest of 35 hours ie 1 day off per week. The consecutive shift results show no safety benefit is apparent for even 1 day off per fortnight.

48 The findings also show no evidence that the safety risks of the different working time arrangements studied were influenced by particular types of work (eg high speed InterCity work compared with stop/start short trip Network South East work), age bands (eg older drivers compared with younger ones), or irregularity in shift start times (eg high daily variability, compared with regular start times). As severity of SPAD consequences increases, the higher risk period moves from daytime to night-time. But the evidence does not then suggest any link to later hours in the shift and hence no link fatigue from long shifts endangering safety.

49 The Study confirms some known issues about safety risks, but also raises some new ones:

(a) that the peak in safety risks in a shift is the early not the later hours. Other studies have found this eg British Coal and Dutch railways, but they have not been able to explain it. For BR it is not explained by the passenger traffic peak effect, the actual time spent driving or any other factor explored. Lack of data prevented examining the effect of mealbreaks;

(b) familiarisation effects may be outweighing fatigue effects over the range of hours studied. The highest risks in consecutive shift working were on the first shift back after a break; longer hours working (up to BR's present limits) had increasingly lower risks eg per shift. The higher risks occurring on first returning to work will be explored further by examining length of time absent;

(c) the evidence that longer shifts are safer and the peak in risks is in the earlier hours, raises questions about short shifts and split shifts. Neither could be studied as they are not found amongst BR train drivers.

(d) self-selection is another factor which may explain certain results. The reduction in risks associated with higher hours working, which presently almost exclusively occur in overtime, may be indicative of self-selection being safety positive. Comparative data is not readily available to test this further;

(e) generally, night-time is shown as safer than daytime. The obvious explanation is the lesser passenger traffic effects outweighing the body clock effects. But this is not so for the more severe events studied. What causes their midnight risk peak, given it appears not to be associated with shift length? Tests by variability of shift start time will be done: a factor the US Railroad Study found to be relevant.

50 Detailed presentations of these findings have been made to BR Board Executive and senior railway managers, the drivers Unions, the Health & Safety Executive (HSE) including the Railway Inspectorate, and the Working Hours SubCommittee of the Railways Industry Advisory Committee (RIAC). The Study formed the basis of the safety validation of proposals to restructure drivers hours and the Board's response to the HSC proposals on regulating drivers hours of work in a privatised railway. It is also to be used by both BR and the HSE in the context of prospective EC legislation.

H L Wharf
4 October 1993

1. GAO Railroad Safety: Engineer Work Shift Length and Schedule Variability (GAO/RCED-92-133): April 1992. GAO Railroad Safety: Human Factor Accidents and Issues Affecting Engineer Work Schedules (GAO/RCED-93-160BR): July 1993

2. H Van der Flier and W Schoonman., 1988. Railway signals passed at danger. Appl. Ergon., 19: 135-141

3. British Coal Study into hour-into-shift accident rates of mineworkers. Study to be published shortly (1993).

DATA VALIDATION

1 Data validation related to

(a) the safety-related event data;
(b) the exposure data used.

(a) Checks on Safety-related event Data

2 The data sources used for capturing the event data is BR's two databases, SPADMIS for SPADs, BRIMS for operating incidents and personal accidents. Both databases are much used for operational and research purposes. SPADMIS is highly focused, the subject of much investment and extension in 1989 and now very comprehensive. BRIMS began in 1990 and represents the industries standard for holding such data, and much of it about statutorily reportable events. Limited sample checks for consistency and errors were conducted.

3 BRIMS investigations did however show there was an improvement in recording standards over the data capture period used (Sept 1990 to Sept 1992). Personal Accidents increased by over half and Operating Incidents more than doubled. Combined with some reduction in high hours working (see paragraph 7 below) this would tend to introduce a bias, lowering the incident and accident rate results for particularly high weekly hours and long runs of consecutive shifts. Initial investigations have shown this had only a marginal effect ie although the event rates in the higher hours have increased slightly, they are still less (although not always statistically significantly less) than the overall average rate.

4 Personal Accidents were especially checked for potential bias of omitting end-of-shift data. Since most accidents depend on the driver reporting the event, there may be less chance of such a report for less serious accidents where no lost time is involved. The checks involved performing the hour-into-shift analyses for lost time accidents as distinct from all accidents: no different results emerged.

5 Some SPADMIS and BRIMS records omitted data needed for various analyses (eg a valid severity code). Further, it was not always possible to match the individuals involved in a safety-related event with their payroll record to obtain the necessary additional data. In these cases, such events were omitted for that analysis and hence the various analyses for the same years do not all use exactly the same number of events. This means the overall average rates can vary slightly eg average SPAD/MDH for September 90 and September 92 varies between 26.10 and 27.09 (on graphs 3, 4 & 6 at Annex B).

(b) Checks on Exposure Data

6 Two types of checks were carried out on the exposure data: checks relating to the

- representativeness of the 2 year period used; and
- accuracy of the data used.

7 The data on booked hours worked related to the 2 year period September 1990 to September 1992. Checks were made to ensure this 2 year normalising period was representative of the 8 year period in which the SPADs had occurred. This was particularly important since following the introduction of"outer limits", longer hours working (per shift, per week and consecutive shifts) had been curtailed. To do this, SPAD/MDH for hour-into-shift results were studied both over 2 years and 8 years. No material difference emerged.

8 Data accuracy was checked because the source of the hours data was BR's payroll the purpose of which is to pay drivers accurately, rather than necessarily record hours actually worked. Use of booked-on to booked-off hours for this Study, removed the prime source of non-worked (but paid) hours eg overtime paid at time-and-a-half. However, local arrangements could affect particularly the booking-off time recorded. Two crosschecks were therefore applied:

(a) a sensitivity test on the results

(b) the effect of using alternative exposure data (ie actual driving hours).

9 The sensitivity test checked accuracy of booked hours. It calculated the error size needed in the payroll booked hours data for the 10th, 11th and 12th hour hour-into-shift results to be at the overall average rate (24.6 SPADs/MDH), instead of their actual calculated result. The tests showed:

Hour-into-shift	Actual Result	Error Size Needed
10th hour	17.3 SPADs/MDH	30% omission
11th hour	11.5 SPADs/MDH	53% omission
12th hour	13.2 SPADs/MDH	46% omission

Even larger errors in the payroll booked hours data would be needed to reverse the conclusions ie show an above-average rate in 10th, 11th and 12th hour similar to the 2nd to 4th hour peak. Errors on this scale are not credible.

10 Not all booked hours (however accurately recorded) will be driving hours and actual driving hours are an alternative measure of exposure. Some of the safety related events can only occur when actually driving (SPADs and operating incidents). This is especially relevant where the relative rates of risk using booked hours or driving hours would differ - as in 1st and last hour-into-shift and during mealbreaks. For most other working patterns studied the relative rates are unlikely to be affected.

11 As already noted, driving hours data was not readily available. A study by BR Research[1] sampled rosters but did not have data on driving hours in overtime (the sole source of all 9 hour+ data). A new sample exercise was done by studying drivers actual records of trips (ie a drivers "ticket") to ascertain driving hours as a proportion of booked hours. As expected, it showed a lower driving proportion in the first and last hours and during mealbreaks. Satisfactory 12th hour driving data proved difficult to capture. The check then involved performing the SPAD hour-into-shift analysis using driving hours (rather than booked hours) as the exposure data. As expected, the 1st hour risks increased, but otherwise the profile remained similar, with lower risks in later hours (up to 11th hour when data ran out), although the peak in risks went back an hour (from 3rd to 4th hr).

1. "An investigation into the Causation of Signals Passed at Danger" by A O Gilchrist, dated January 1990, Report Ref: TM TAG 138. (Final report of a 3 year study undertaken by Royal Holloway and Bedford New College and BR Research from October 1986 to October 1989.)

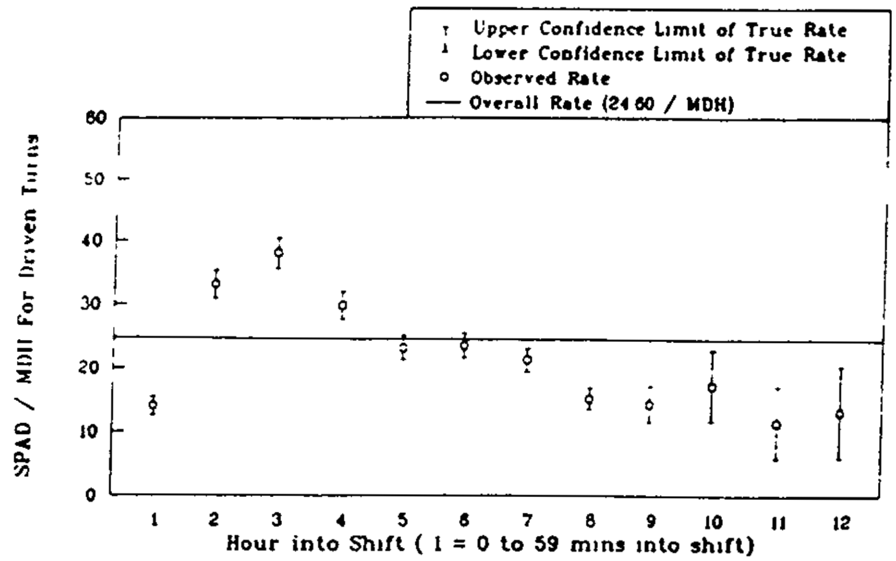
ANNEX B

GRAPHS OF THE KEY RESULTS

1. Hour-into-Shift
2. Hour-of-Day
3. Consecutive Shifts Worked-in-spell
4. Hours Worked in the Last Seven Days
5. Average Weekly Hours Worked Over the Last 13 Weeks
6. Length of Last Rest Period

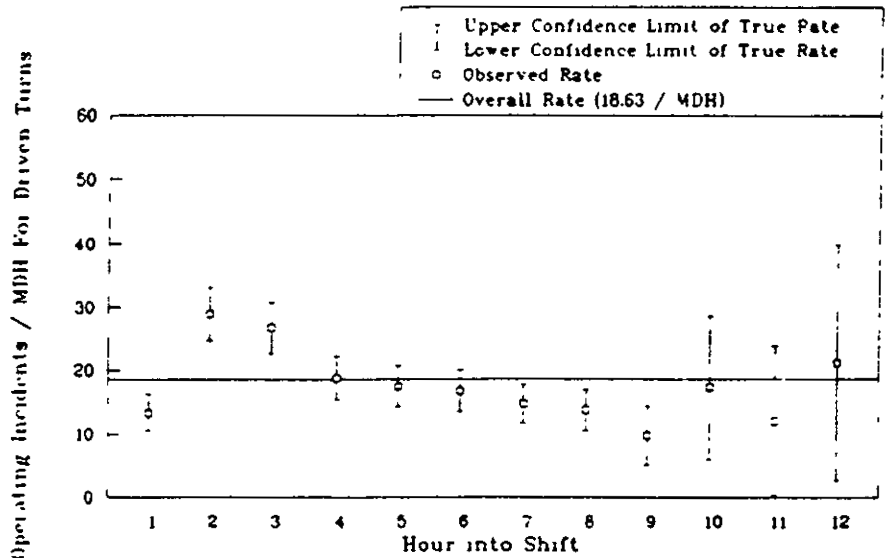
Many other graphs of the supporting evidence provided in paragraphs 23 to 42 are available.

SPAD Rate / Million Driver Hours (MDH)
By Hour into Shift of Driven Turns (1985 - Sept 1992)



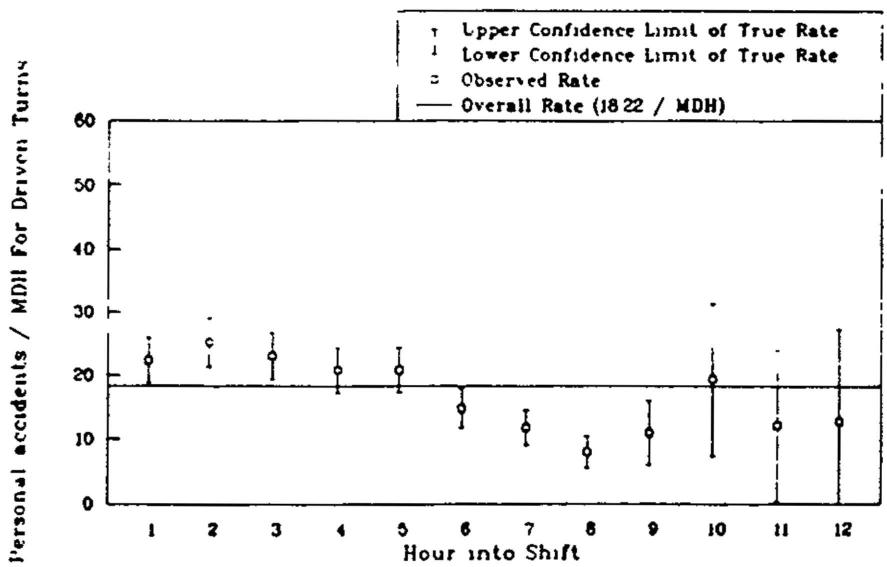
(excluding those identified as Driver not responsible)

Operating Incident Rate / Million Driver Hours (MDH)
By Hour into Shift (Sept. 1990 to Sept. 1992)



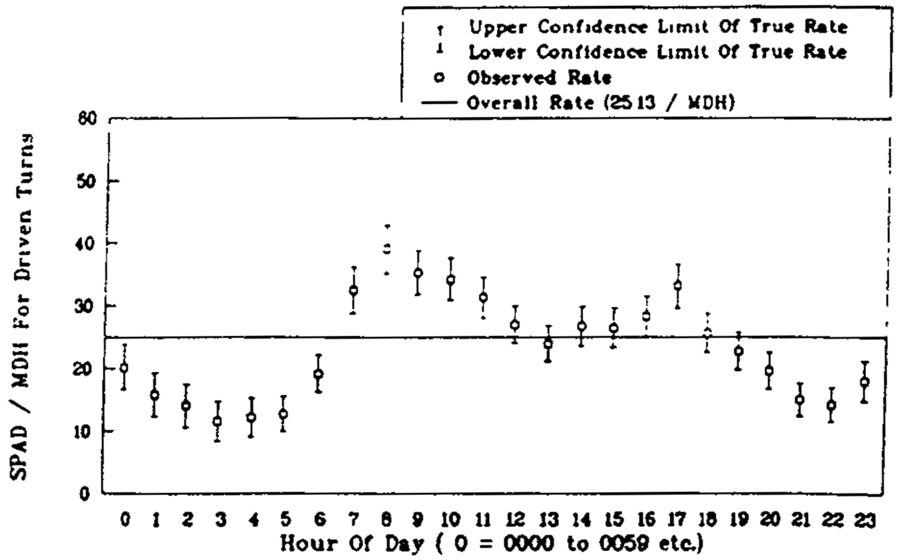
(excluding those identified as Driver not responsible)

Personal Accident Rate / Million Driver Hours (MDH)
By Hour into Shift (Sept. 1990 to Sept. 1992)



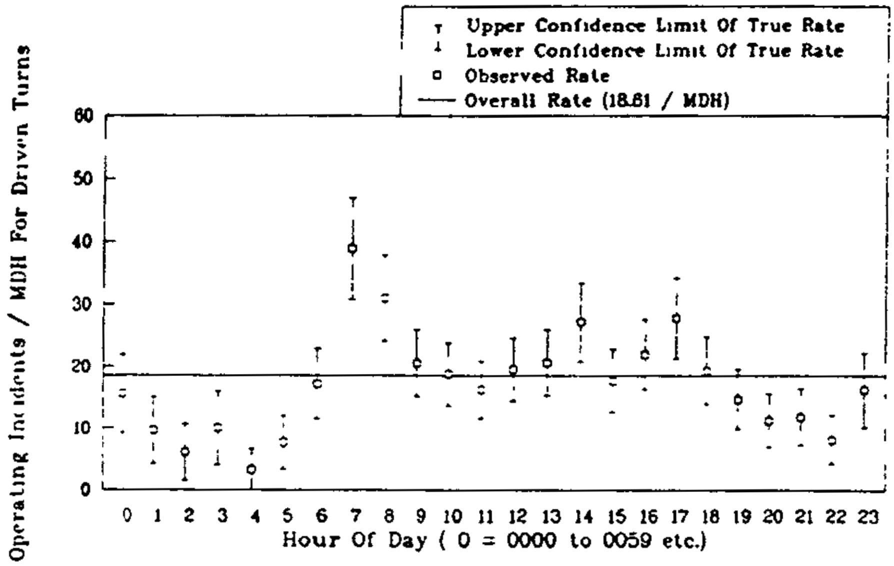
(excluding those identified as Driver not responsible)

SPAD Rate / Million Driver Hours (MDH)
By Hour Of Day (1985 to Sept. 1992)



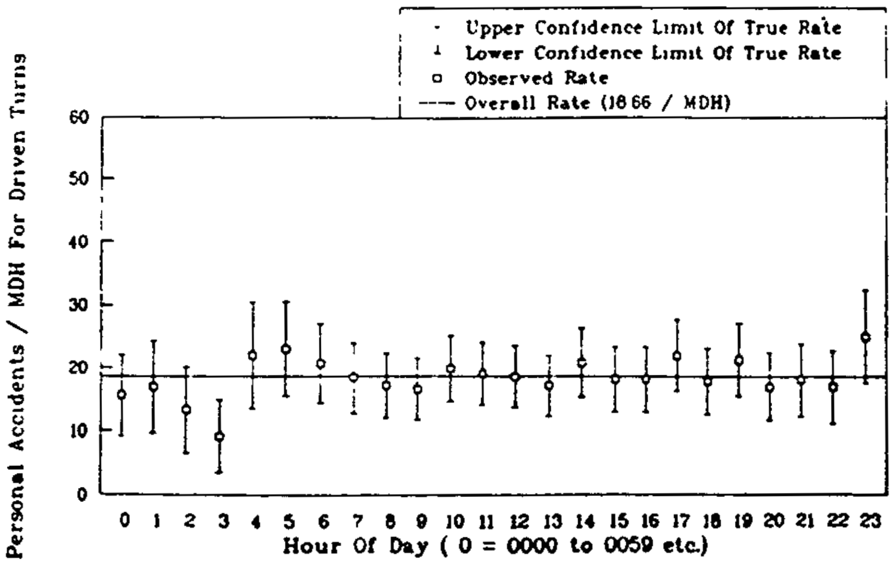
(excluding those identified as not driver responsible)

Operating Incident Rate / Million Driver Hours (MDH)
By Hour Of Day (Sept. 1990 to Sept. 1992)



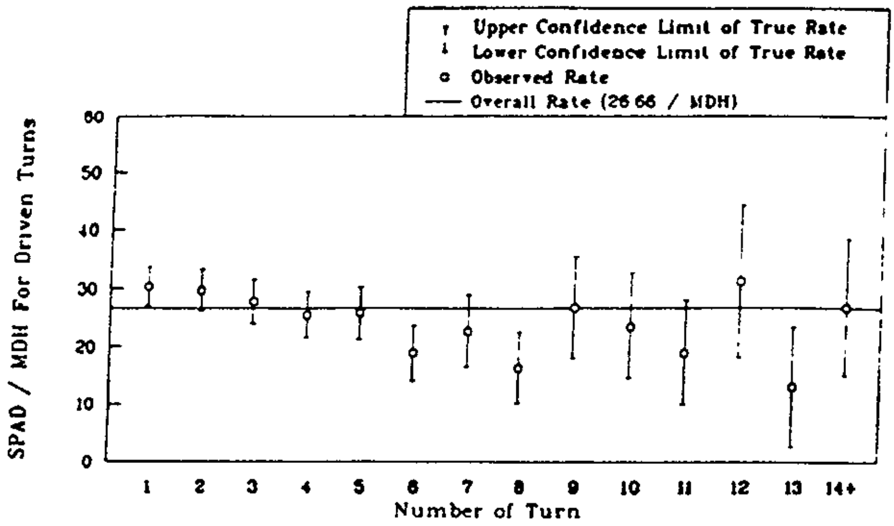
(excluding those identified as not driver responsible)

Personal Accident Rate / Million Driver Hours (MDH)
By Hour Of Day (Sept. 1990 to Sept. 1992)



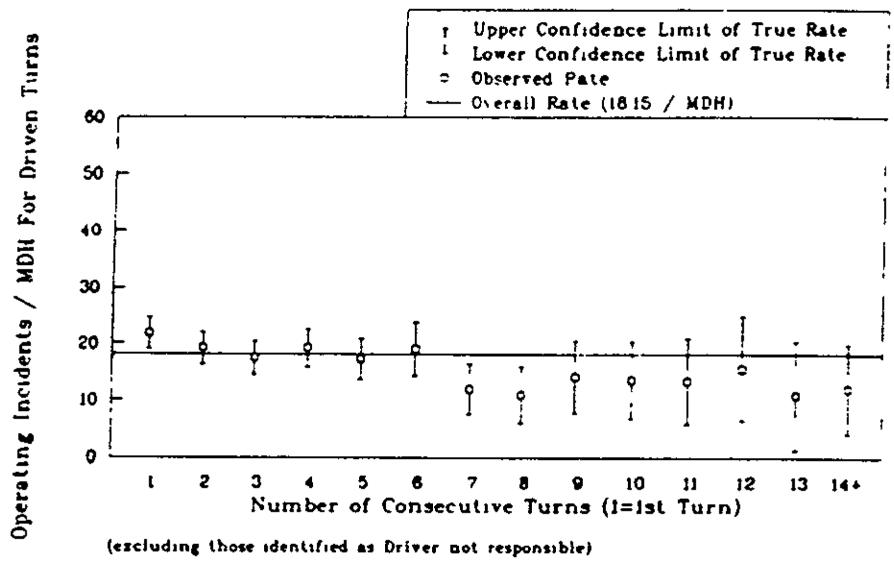
(excluding those identified as not driver responsible)

SPAD Rate / Million Driver Hours (MDH)
By Number of Consecutive Turns Worked
(Sept. 1990 to Sept. 1992)



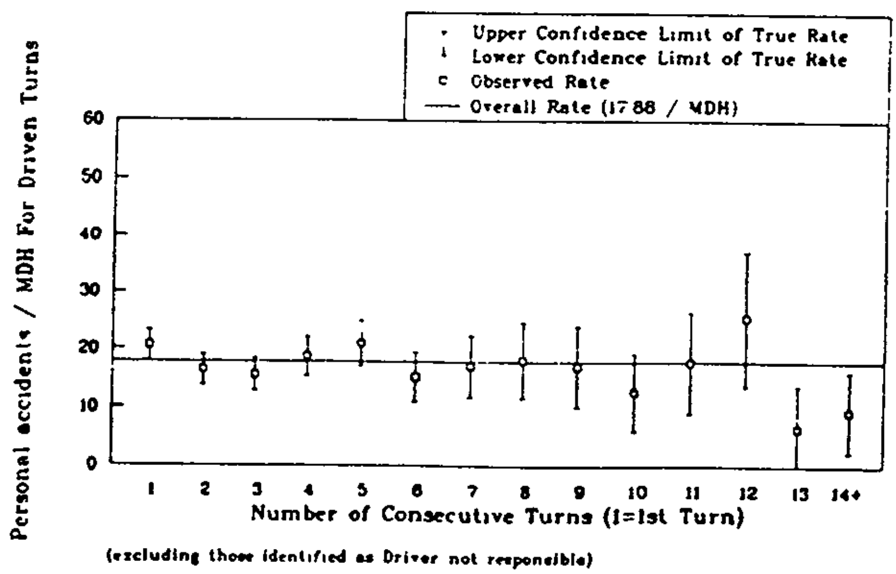
(excluding those identified as Driver not responsible)

Operating Incident Rate / Million Driver Hours (MDH)
By Number of Consecutive Turns Worked
(Sept. 1990 to Sept. 1992)



(excluding those identified as Driver not responsible)

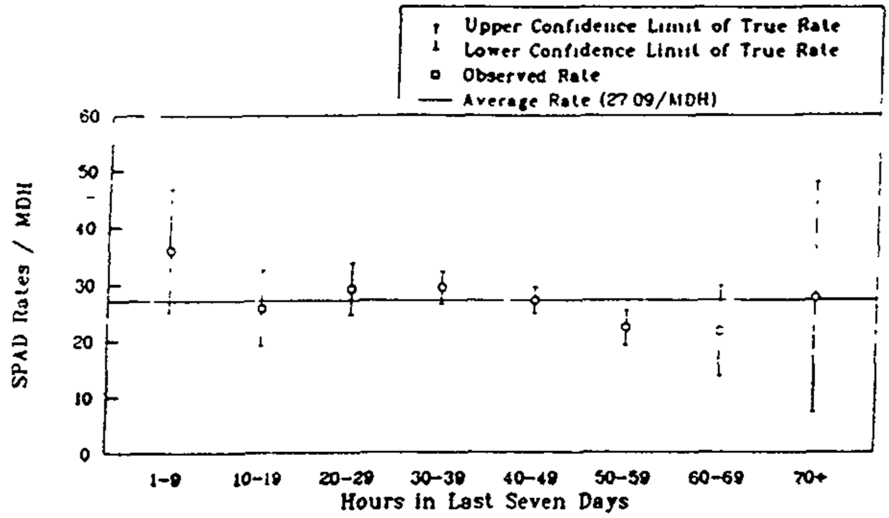
Personal Accident Rate / Million Driver Hours (MDH)
By Number of Consecutive Turns Worked
(Sept. 1990 to Sept. 1992)



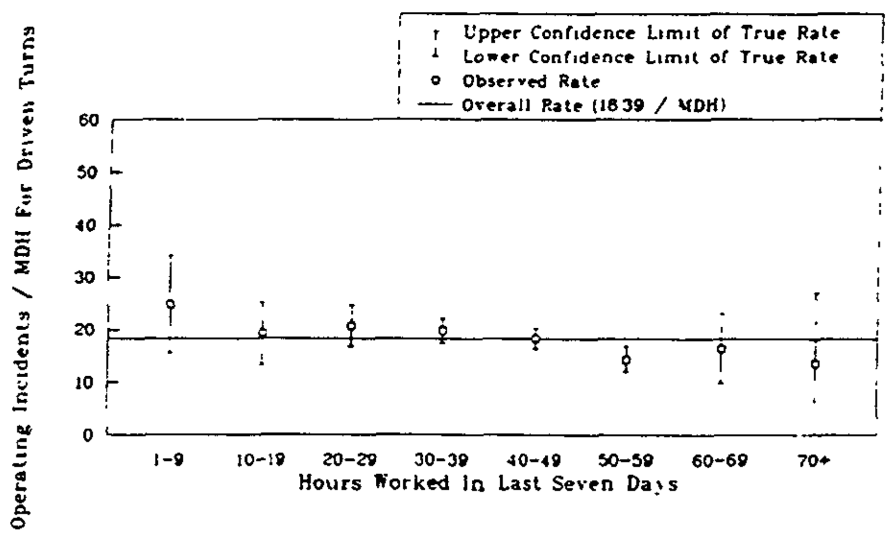
(excluding those identified as Driver not responsible)

4

SPAD Rates Per Million Driver Hours
By Hours Worked in the Last Seven Days
(Sept 1990 to Sept. 1992)

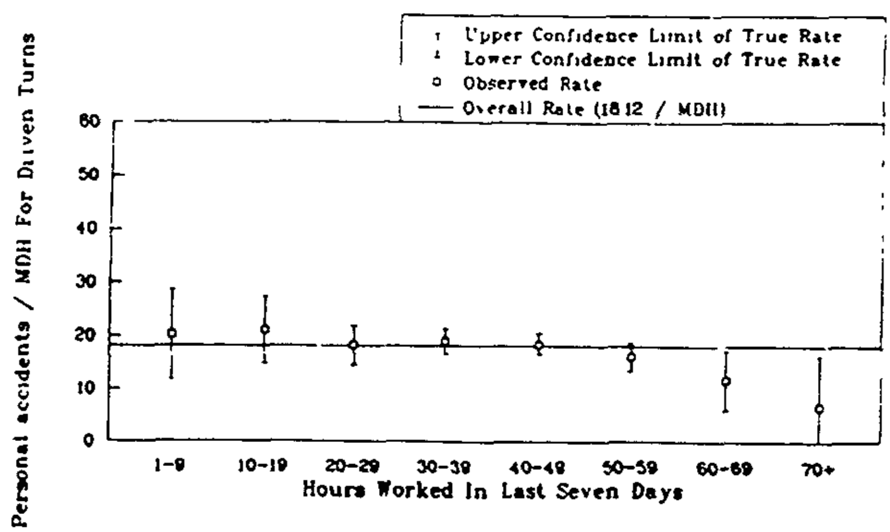


Operating Incident Rate / Million Driver Hours
By Hours Worked in Last Seven Days
(Sept. 1990 to Sept. 1992)



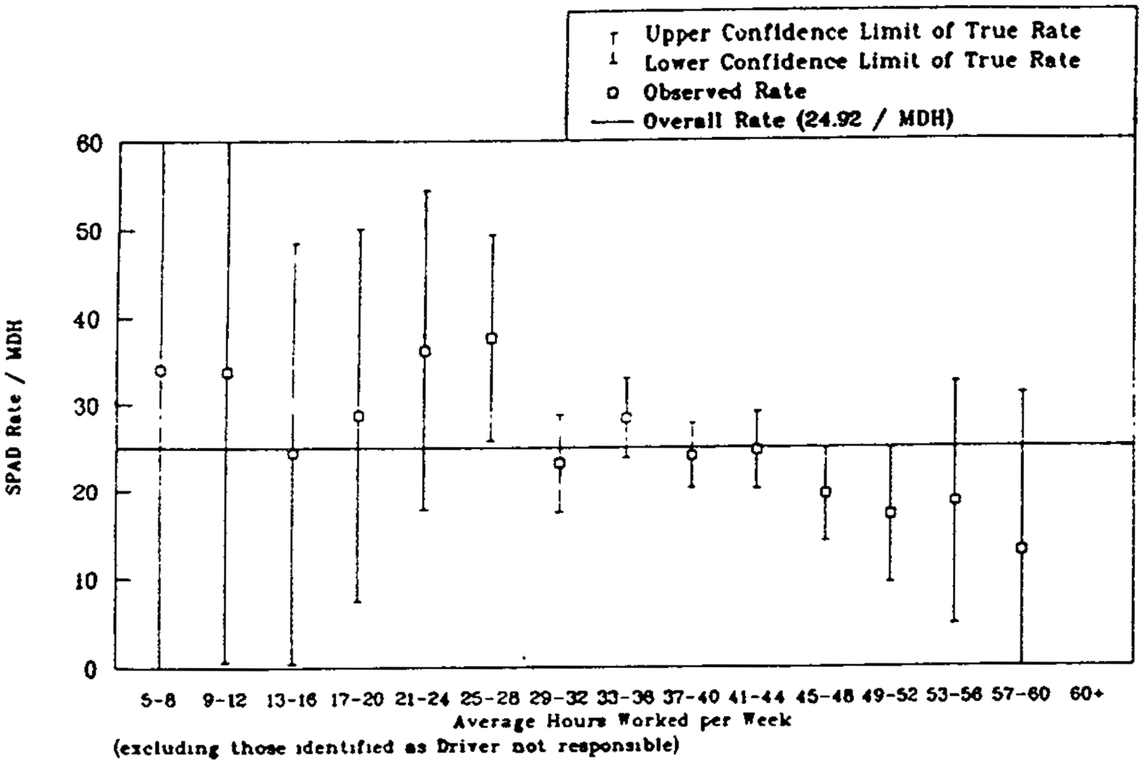
(excluding those identified as Driver not responsible)

Personal Accident Rate / Million Driver Hours (MDH)
By Hours Worked in Last Seven Days
(Sept 1990 to Sept 1992)



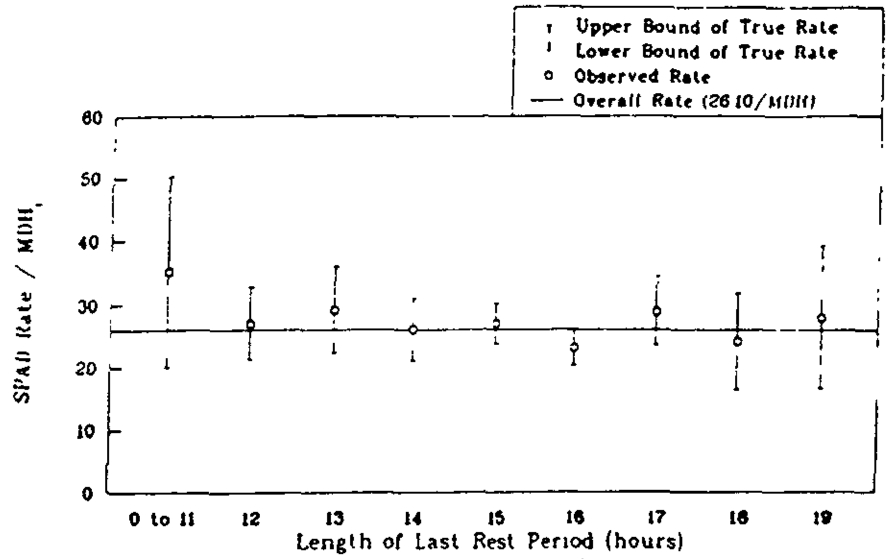
(excluding those identified as Driver not responsible)

SPAD Rate per Million Driver Hours (MDH)
By Average Weekly Hours Worked Over the Last 13 Weeks
(July 1991 to Sept. 1992)



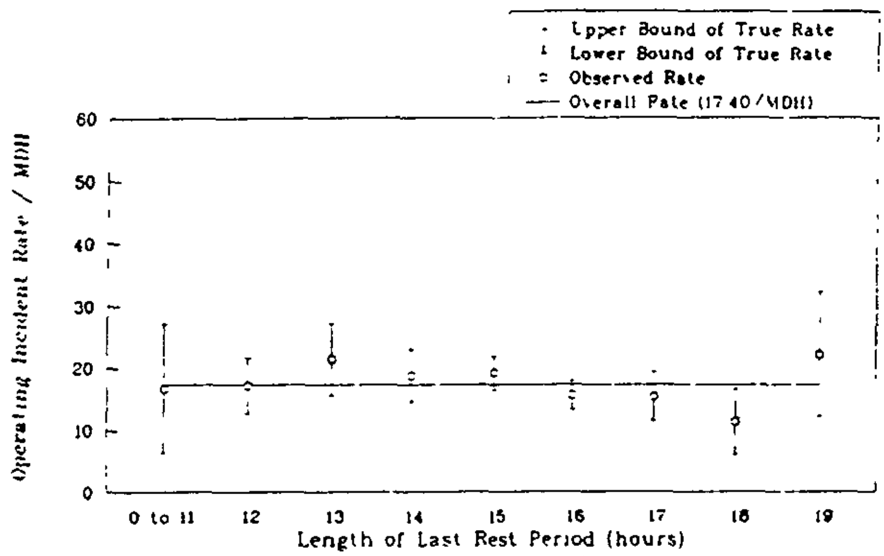
6

SPAD Rate per Million Driver Hours (MDH)
By Length Of Last Rest Period
(Sept 1990 to Sept 1992)



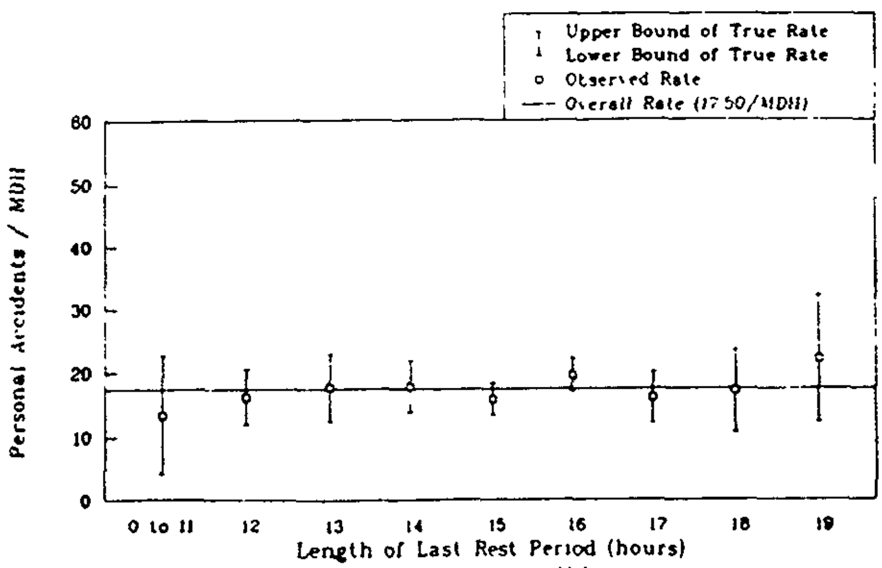
(excluding those identified as Driver not responsible)

Operating Incidents per Million Driver Hours
By Length Of Last Rest Period
(Sept. 1990 to Sept 1992)



(excluding those identified as Driver not responsible)

Personal Accidents per Million Driver Hours
By Length Of Last Rest Period
(Sept. 1990 to Sept 1992)



(excluding those identified as Driver not responsible)

International Rail Safety Conference

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9315

Robert Loncle

Research on human factors cooperation between SNCF and social sciences researches. Example: track workers' safety

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

RESEARCH ON HUMAN FACTORS : COOPERATION BETWEEN SNCF AND SOCIAL SCIENCE RESEARCHERS EXAMPLE : TRACK WORKERS'SAFETY

Robert LONCLE

Head of Human Factors Unit
Personnal Direction
SNCF

A -HOW TO IMPROVE OUR KNOWLEDGE OF HUMAN FACTORS ON THE RAILWAY

1°/ In cooperation with human and social science laboratories

2°/ Trackmen's safety at work

B - HOW CAN TRACKMEN MANAGE AND CONTROL CONSTRAINTS IN CONNECTION WITH HAZARDOUS SITUATIONS ?

1°/ Four stages

2°/ Analysis models developed and developed

3°/ Five critical accident-patterns

4°/ Suggestions for preventive action - How to use the findings ?

C - CONCLUSION

To pursue cooperation with researchers

D - APPENDICES

1°/ Four Analysis models

Model of Surry
Model of Rasmussen
Model of Hale and Hale
Model of Hale and Glendon

2°/ Scenario example

A - HOW TO IMPROVE OUR KNOWLEDGE OF HUMAN FACTORS ON THE RAILWAY?

1°/ Cooperation with human and social science laboratories

During the past few years, SNCF has been laying more emphasis on human factors, in conjunction with railway safety in particular.

This includes research-work carried out by ourselves or in cooperation with external research laboratories associated with various universities.

This usually takes a long time and we have to be careful when coordinating work between researchers and SNCF operative staff and managers/engineers in order to achieve constructive results.

As a matter of fact, we expect engineers and managers to be able to have direct access to the findings of the research when they develop technical systems and operating rules or when they organize the workers' activities, .

This research-work may involve ergonomic, psychological and sociological aspects.

Some factors are already reflected in overall projects for new systems in terms of technical and human aspects: for example the research on ASTREE (automatic control system for the future) or on the new TGV generation (what is the driver's role and what driving-aids are available to him/her ?).

Other research-work relates to operating and maintenance activities : for example train drivers, traffic controllers, signalmen, trackmen and rolling stock maintenance staff.

For each subject we try to call upon academic experts in the various disciplines in order to get a wider range of views.

Throughout the project, a scientific committee[1] assesses the whole research-work : the specification for the research-theme, methodology applied, cooperation with engineers, managers and workers, findings.

2°/ Trackmen's safety at work

Our research-work on trackmen's safety is twofold :

First, a socio-historical approach to track maintenance and gang safety :

- gangmen's age-profiles, training profiles, abilities and skills, relationships between gangmen and with their managers, ...
- technical developments in trackwork and their impact on the track-maintenance activity, equipment and tools used, communication systems, organization of trackmen's work, working time, ...
- how have we exploited feedback information derived from past accidents in this area of activity ?

[1]That scientific committee is composed of Research Office, and researchers from INRS, CNRS, INRETS.

(This research-work was carried out by Mr. George RIBEILL, chief researcher and lecturer in sociology, expert in railway-matters.)

Secondly, a more psychological and ergonomic approach.

The researchers analyse the ways in which track maintenance crews cope with hazards on the running line while at work.

From an ergonomic view point an initial analysis of trackmen's working conditions has shown the diverse and variable situations encountered which involve a range of hazard combinations.

The most critical combinations called "patterns" have thus been identified. To detect those potential dangers, it was first necessary to analyse the different levels of safety management and planning, and to consider the possible interference between the requirements of productivity and safety.

Researchers have developed a method for the analysis of hazard control patterns, which is based on the "Hale and Glendon model". This method is helpful to characterize the behaviour of trackmen when faced with safety-risks at work.

(It was jointly conducted by Mrs Annie WEILL-FASSINA, chief researcher and professor of psychology and ergonomics and Mrs Cecilia De La GARZA, researcher.)

The following text gives some detailed information about of the latter.

B - HOW CAN TRACKMEN MANAGE AND CONTROL CONSTRAINTS IN CONNECTION WITH HAZARDOUS SITUATIONS?

1°/ Four stages

The investigation is made up of four main stages :

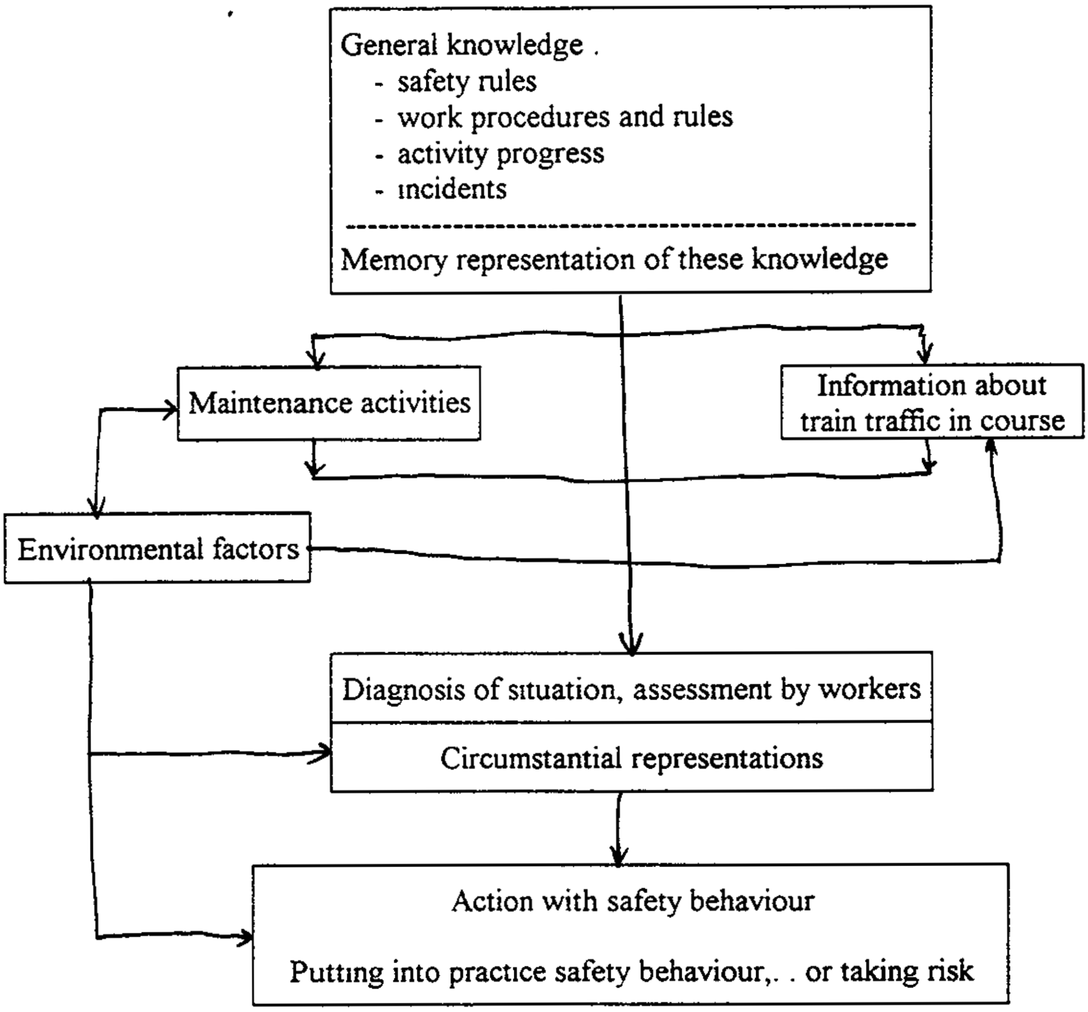
a) A bibliographic analysis of workers' behaviour in hazardous activity :

- the process of danger-detection,
- models used to identify and represent such processes,
- reasons for success or failure in such a process;

b) A first review consists in examining track maintenance activity, identifying key-factors in the organization and management of productivity and safety :

- coordination between operating and maintenance services,
- organization of maintenance operations,
- safety rules & regulations and implementation by trackmen,
- managers' remits (permanent way inspectors, foremen, ...),
- technical resources and tools used,
- trackmen's know-how.

Following the bibliographic review, and the initial examinati... of track maintenance-activity, the provisional conclusion boils down to considering t... accident situation as a system which includes environmental aspects, task-achievement, technical factors and past experience. This model may be illustrated by the picture below :



c) Analysing previous accidents :

Researchers have evaluated the various accident-analysis methods applied by SNCF :

- Statistical analysis : relationship between accidents and environment, age, time when the accident occurred, ...;

  Although this analysis is helpful, it is not easy to decide upon preventive measures accordingly since it does not produce a reliable representation of events and their succession on the spot;

- Fault/event tree:

  For several years, SNCF has been encouraging managers to apply such a method. Its multidimensional character helps us understand and show the linkage between several causes;
  This method is very useful to improve the informational feedback loop from operational experience on safety, especially when trackmen are closely involved in the development of the feedback-process ;
  But fault trees can't take into account the time-dimension and dynamic character of events.

Then the researchers suggested studying other methods for analyzing incidents.
They tried to define and apply new models which may be more relevant and suitable for ever-changing situations and teamwork.

They finalized the methodology on a few typical instances of accidents, in order to define all multidimensional elements in the accident scenario :

- organization, processes and procedures,
- physical and technical factors,
- traffic,
- information available,
- planning, schedule, relative timing of actions and events;
- ....

Then they applied the model on 24 fatal or serious accidents which occurred during the past few years.

In each case, they set up a scenario emphasizing the determining factors in the accident and their interaction.

The correlation between these instances led to five typical patterns which result from a combination of several elements.

d) validation based on actual work :

Then, they had to validate their assumptions by an extensive field study conducted on the railway tracks.

- they interviewed track workers, gang foremen and managers;

The objective was to make sure that the circumstances leading to accidents were very similar to the actual track-maintenance conditions in terms of :

- organization,
- planning activity,
- relationships with operating officers,
- variability of working conditions,
- workers' behaviour,
- ....;

Then they suggested preventive actions for the future.

2°/ Analysis models developed and used

An accident cannot be summarized as a human error due to non-compliance with rules. From a systemic view, the accident appears as the combination of several factors interacting dynamically.
Such factors do exist in trackwork activity and are generally managed and controlled. But, this control may fail.

What does such control consist of? :

Four different stages can be identified during trackwork maintenance operations:

- preparation stage (planning of the work);
- actual commencement of trackwork (balance between constraints and resources);
- the activity under progress (management and control of hazards and incidents);
- train approach (critical phase for danger control).

Different people come to act at these different stages while each of them controls constraints and takes decisions according to his representations of the risks and situation under consideration .Individual behaviour takes place alongside with team response.

The initial review showed that circumstances leading to accidents may occur at any above-mentioned stage. These circumstances can affect the way in which people make up their representations of the situation and they may lessen risk control.

Models of analysis :

Different models were used to analyse the representations construction which lead to decisions and actions : (see appendix one)

Model of Surry
Model of Rasmussen
Model of Hale and Hale
Model of Hale and Glendon

These models were not implemented directly, but their principles were applied to track workers in order to develop "the control of danger" model.

Alongside with this model , the researchers drew up a questionnaire on accidental circumstances or vulnerable events known as "critical events" which led to the fatal outcome.

The scenario :

The information about the accident is identified and classified in a table (see appendix two) giving :

- On the horizontal axis, the activity timing over the four stages of track work management, which can be further subdivided if necessary.
- On the vertical axis, all the features which help identify and classify activity-data.

  This data is compiled into nine headings which seem relevant for the trackmens' activity :

  - Environmental conditions (visibility, noise, night-work, etc...);
  - Track work (planned/unplanned, organization,work-phase, task, equipment and tools);
  - Work-scene (location, people's movements);
  - Running of trains (organization, protection, track-category);
  - Safety organization and/or train-announcing procedures (protection-devices, announcer, transmission of signal announcing the train);
  - Traffic density (requiring interruptions during work);
  - Protection enforcement (sending out and receiving train-announcing signals, clearing the track, work resumption);
  - Unformal information;
  - Non mandatory activities (remedial action).

Example : (see appendix two)

In this example, you can see an accident scenario. The scenario helps us identify and analyse the "critical events" i.e. circumstances which played a decisive part in the outcome.
The "control of danger model" can be used to reflect upon "critical events".

Scenario interpretation :

The analysis of critical events is conducted through the four stages in trackmen's activity, in order to draw up a conclusion as to the main contributing factors .

3°/ Five "Patterns" - Recommendations to be made

Comparison of accidents :

Then the researchers made a comparative analysis of accidents. They used a comparative table with the significant accidental circumstances and were able to show five scenario/pattern models :

-A- people slipping when the train is approaching;

-B- system-disruption while the activity is in progress;

-C- weakening of the system in the planning stage and/or during the start of the activity;

-D- weakening and destabilisation affecting the four work-stages;

-E- weakening of the system in the planning stage and/or in the starting stage, and destabilisation upon train approach;

<u>Thorough analysis of accidental circumstances and validity of the research approach</u> :

The four following items show the circumstances leading to accidents, in terms of working conditions :

- Environmental conditions :
  - track lay-out and train-speed;
  - noise-levels
  - visibility limits.
- Overall organization-plan and safety measures affecting track-work :
  - engineering-work programs, unplanned tasks, work overloads;
  - coordination with the Train Operating Department;
  - safety-related measures, as planned by line-management and trackmen
- Activity development and organization :
  - trackmen often moving beyond the limits of a protected area, as a result of a difficulty or of their actual work;
  - incidents caused by tooling;
  - conflicts between maintenance and safety which lead to difficult decision-making;
  - interference between train-operations and trackwork which may impede work when the number of trains is too high.
- Protection rule enforcement upon train approach :
  - train-announcing signal : non-existent or delayed;
  - risk detection by trackmen : non-existent, delayed or inappropriate;
  - clearing of the track : non-existent or giving rise to slips or incidents.

At each stage of the safety and work-management process, operators have to control all constraints and to allow for all safety and production requirements. Trackmen should also cope with hazards and unexpected situations encountered on the railway.

This approach to work management by individuals and by the group shows how, in the light of experience, trackmen add on an all encompassing safety logic over and above the regulatory logic. So the proposed steps to prevent accidents at work should therefore be based on revised planning, communication-means, rules and regulations .

Such approaches can be used to improve the feedback-process :

- as a systemic approach to incident analysis;
- as a means to increase employees' awareness by investigating into actual cases with this model thus reflecting situations encountered at work.

4°/ Suggestions for preventive action - How to use the results

The purpose of our cooperation with social science researchers is not only to come up with new theoretical approaches but to disseminate knowledge about human factors withinin the company and to improve staff-skills in this field. It is meant to be an aid, through specific models and methods, to managers who conceive the safety-system for the benefit of trackmen.

Within this framework, the results are threefold :

a) Direct suggestions for preventive action concerning :

- work organization of track-gangs, and adapting such an organization to the nature and size of track-maintenance operations;
- format and content of documents and procedures in use;
- communication-means;
- training reflecting the need to face variable conditions (contigencies, emergencies), and allowing for all constraints and requirements associated with productivity, safety, timing of tasks,influence of train-operations, ...

b) How to use the "control of danger" model to improve feedback :

At first sight, this methodology seems to be complicated. We would not necessarily use it as such.

This method comes in addition to other traditional tools (statistical analysis, events tree, ...); it is useful for the thorough analysis of typically dynamic situations, including teamwork in particular.

The model may be adapted to non track-work situations.

In such a case, the use of this model seems quite natural to experts, managers, and workers because the approach is similar to their way of carrying out their work.

Moreover when feedback is debated with workers, they usually blame us for stressing only one factor which seems to be the main cause for the accident, rather than taking all the elements involved in the accident into account.

Thus, that methodology is a useful means to study incident situations, associating managers, engineers, gang-chiefs and workers, in order to define and implement preventive action.

Of course that methodology does not solve every single problem, and its effectiveness depends on the way it is used.

For each of us, its also a motivation for taking in account ergonomics and the whole aspect of human factors in the development of new projects.

We should underline that the systemic approach to incidents or accidents does not, in any case, rule out individual responsibility and liability.
We recently initiated a high-level debate on the issue of liability and its interaction with : social behaviour,, public opinion, media response, legislation, lawyers, magistrates or legal procedures.
This subject can't be addressed in this paper.

c) <u>The transfer of knowledge to experts and operational track maintenance staff, is to be pursued in the future</u> :

During the whole research activity, there were numerous contacts between researchers and workers, engineers and managers with a view to exchanging knowledge :

- vis-à-vis SNCF staff: ergonomic, sociological and psychological concepts ...;
- vis-à-vis researchers: knowledge and explanations about track maintenance activity, specific features about railway workers, railway safety requirements , ...;

Those discussions have been genrally so successful that track maintenance managers wished to extend co-operation with this research laboratory to similar subjects.

C - CONCLUSION

When we began to cooperate directly with external human and social researchers we were looking for constructive results, but we were not sure about the outcome.

This co-operation-exercize needs to follow the methodology and to comply with the professional rules of conduct when preparing the research-work and subsequently. When the outcome is satisfactory, which was the case here, this work is quite helpful for several reasons :

- suggestions capable of being implemented by the company;
- transfer of knowledge and enhanced skills through the numerous consultations made during the research activity;
- the relationship of trust established between researchers and company's staff, will be furthered thus enabling discussions on different projects and choosing better options in terms of procedures, documents, organization, training, feedback, design of equipment and tools, ...

This cooperation-exercize becomes easy and positive because staff are more inclined to trust researchers and researchers are better acquainted with railway staff activities.

D - APPENDICES

1°/ Four analysis models

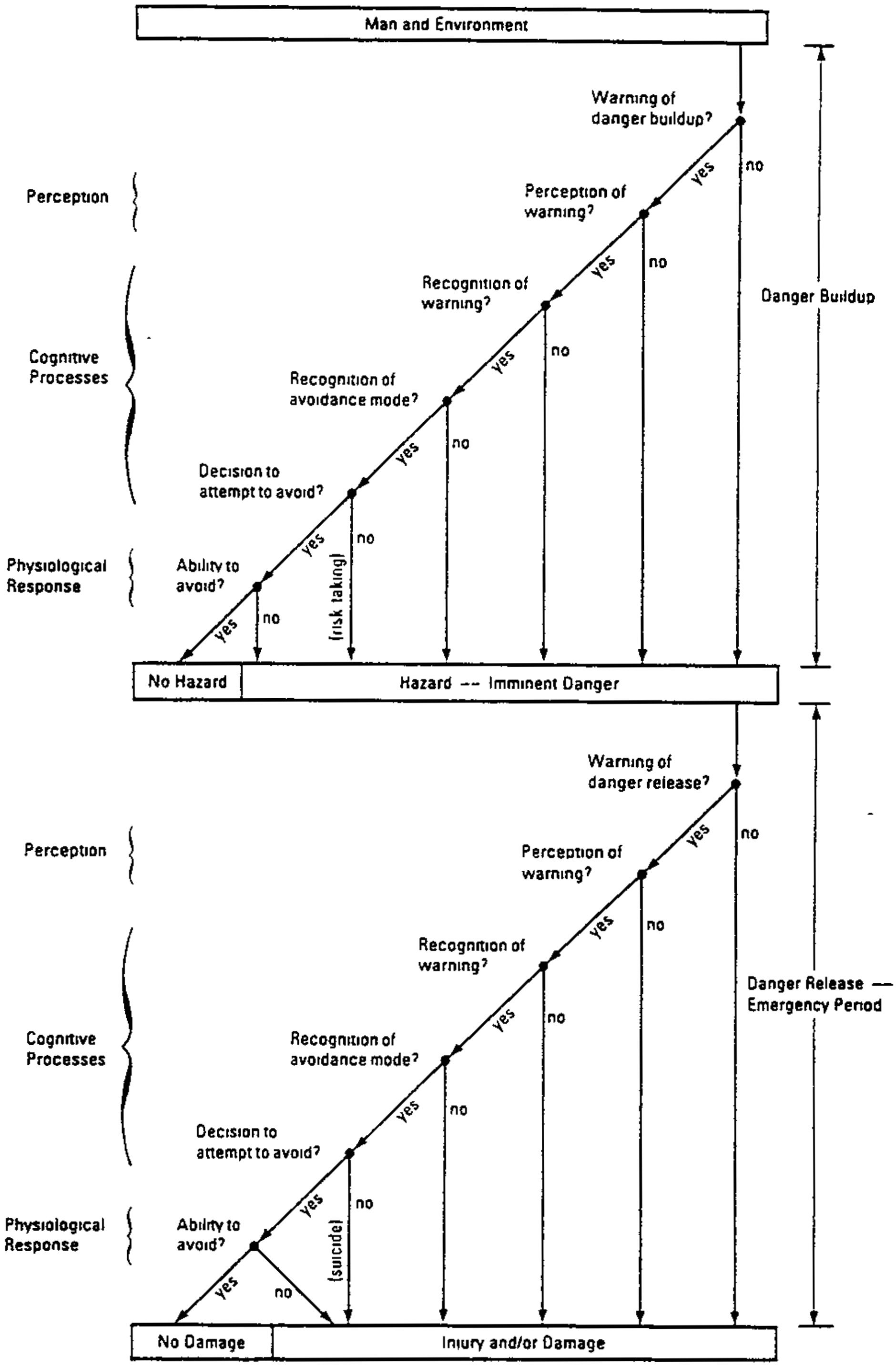
Model of Surry
Model of Rasmussen
Model of Hale and Hale
Model of Hale and Glendon

2°/ Scenario example

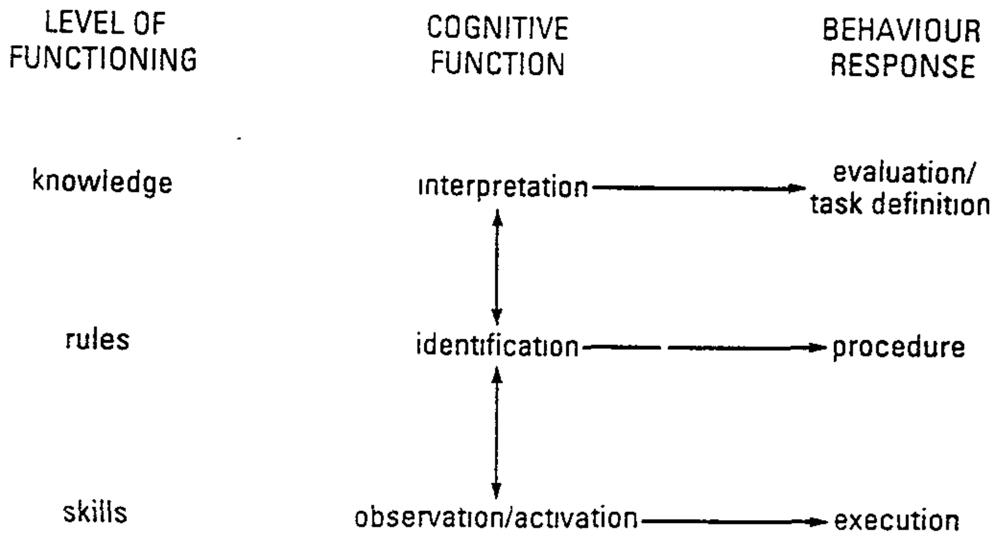
APPENDIX 1

Four analysis models

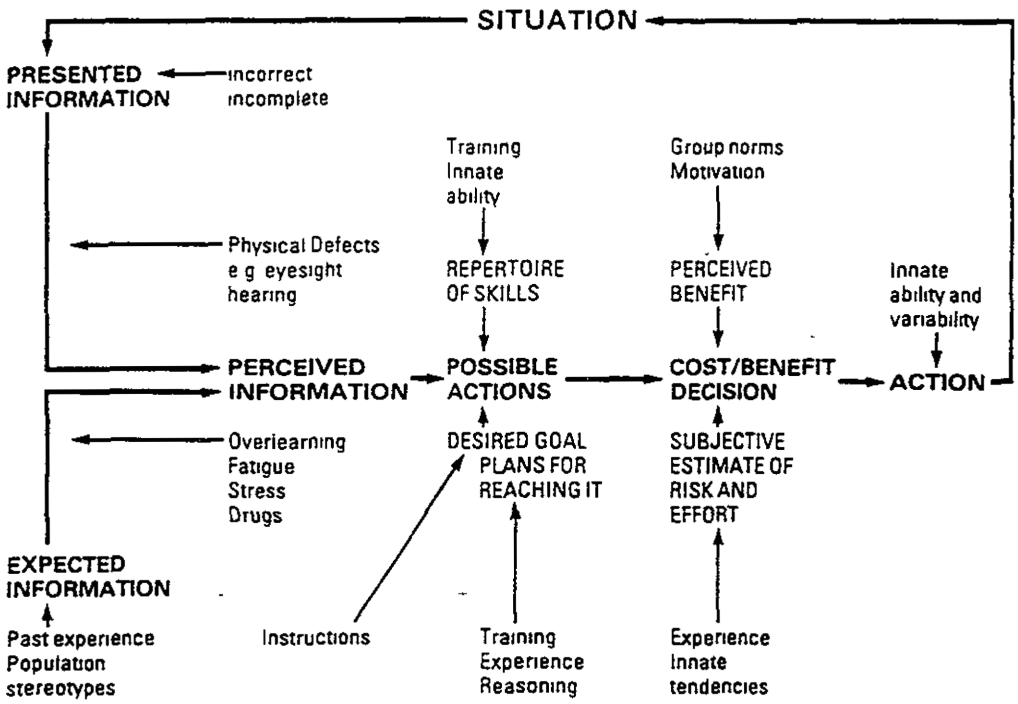
- Model of Surry
- Model of Rasmussen
- Model of Hale and Hale
- Model of Hale and Glendon



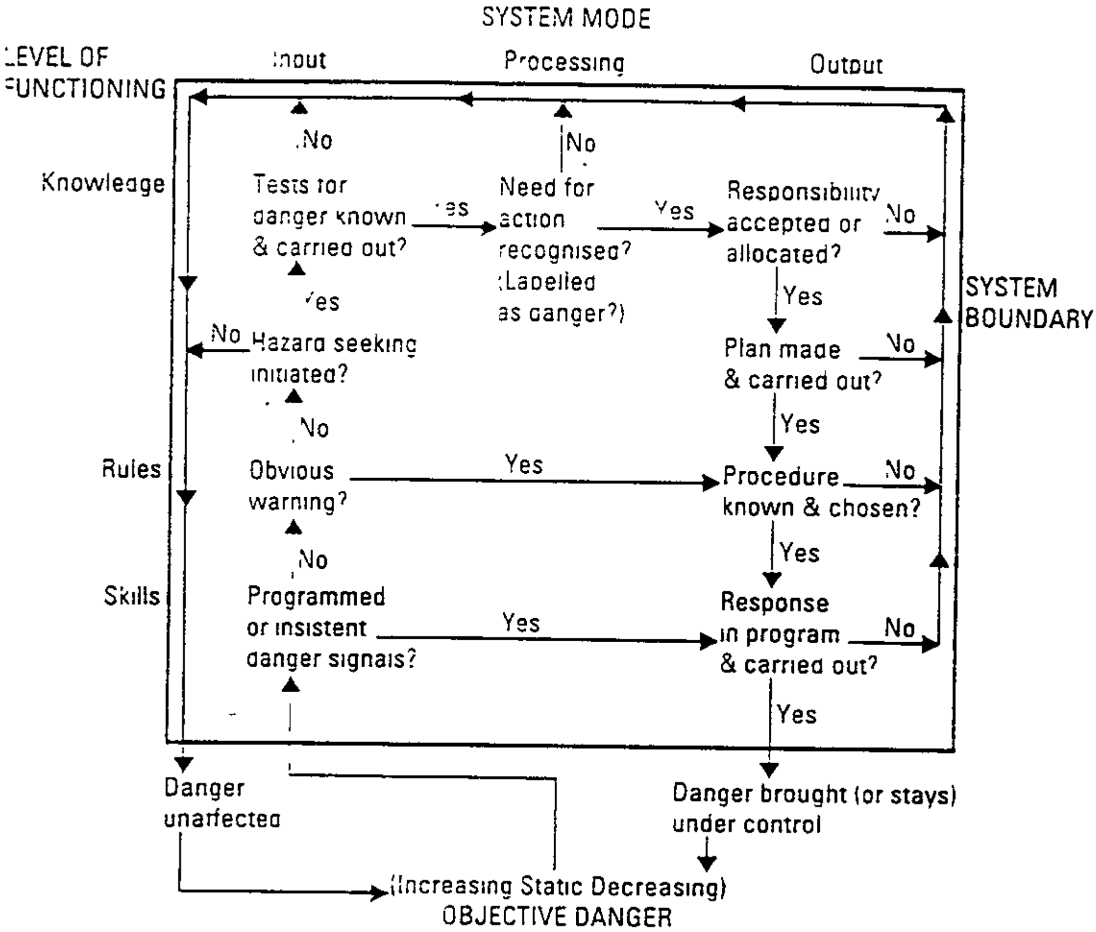
Decision model of the accident process (Surry 1969)



Rasmussen's model of levels of functioning



Model of accident causation (Hale and Hale 1970)



Behaviour in the face of danger model (Hale and Glendon 1987)

APPENDIX 2

Scenario example

nario example : a sleeper screw driver hit by a train

	Preparation stage	Start of the activity		Activity progress			Train approach	
nvironment sibility (weather, track lay out)	Polluted cutting Bright weather							
oise (surroundings, arshalling yard, equipment)	Sleeper screw driver							
ay work or night work	Day							
/ork ind (planned or unplanned)	Included in weekly planning …/…							
rganization ianagers, number of workers, ianges in the field)	Crew 1 foreman in charge of workers and trains safety							
iase	Second week of works on points and crossings							
isk or activity	Fastening crossing by means of a sleeper screw driver	Preparation of the work		Positioning the sleeper screw driver on track 1 for fastenings on main and diverted lines	When fastening the points on the diverted line the sleeper screw driver may be impinging upon the track gauge		Precipitation in the crew, the sleeper screw driver is impinging upon track gauge when it derailed	
quipment	Sleeper screw driver heavy and with …/…							
/ork scene /ork location eople's movements ormal/informal)	Line 1 in a cutting near the station							
rain running raffic organization rotection	Protection on first track (train running prohibited) …/…	Foreman goes to the station Foreman asks Station Operator for protection on track 1	Protection OK on track 1 from 10 15 until 10 40		Foreman goes to see the Station Operator Foreman asks Station Operator for protection on track 2		Foreman is with the crew	
rack type (single, double,) peed frequency, direction	Double track Max. speed 120 km/h							
afety organization / nnouncing ormal information echnical arrangements, nnouncing systems)	Protection on first track …/…		Foreman decides to begin the work …/…		…/…			
ransmission of train nnouncing signals listance, announcement timing)								
raffic density iterruptions								
rotection enforcement ending out / reception							The train is approaching on track 2 without stopping at the station	
learing of the track (workers nd equipment Vork resumption								
nformal information useful or not)			…/…				The conductor of the sleeper screw driver is surprised	The sleeper screw driver is hit by the train
lon mandatory activities						Station Operator says a train is coming on track 2		
Remedial actions							Foreman advises to the crew as to the approach of the train on track 2	Emergency braking of the train

…/… Critical events analysed by use of "Control of danger" model

International Rail Safety Conference

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9316

Dr. Francine Keravel

Feedback analysis of human error for a better management of risk

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

FEEDBACK ANALYSIS OF HUMAN ERROR FOR A BETTER MANAGEMENT OF RISK

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FEEDBACK ANALYSIS OF HUMAN ERRORS
for an improved risk-management system.

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French National Railways

SUMMARY

From time to time a railway accident hits the headlines and highlights the need for specific preventive measures. However the safety of the rail transport system not only depends on such high profile events but also on the need to integrate information from past experience as a whole. For several years, French National Railways (SNCF) has focused its attention on global safety and assessment of investment's options. A detailed analysis of 900 critical events indicates that in 64% of them, human actions are directly involved. This paper describes the model of human factors analysis and identifies the targets set by the multidisciplinary team known as "the Center for Safety Studies".

INTRODUCTION

Human Sciences contribute to the improvement of knowledge in the management of risk and help to integrate the requirements of system reliability. When approaching system-design, an engineer assumes a priori that human performance will be consistent and efficient but experience tends not to confirm such an attitude.

Three multifactorial aspects of research are relevant to this problem :

- identifying the risks of behavioral change,
- detecting the early signs of behavioral change,
- specifying difficulty-indicators in the life of individuals.

Using this overall approach we will now describe the knowledge of human behaviour in order to improve railway safety.

1. LINK BETWEEN RELIABILITY AND FEEDBACK EXPERIENCE

Traditionally safe, the target has always been to maintain a very high level of safety in the design and operation of its different technical systems. The initial concerns about reliability and safety techniques have recently added the concepts of system-availability and maintainability and the emergence of the new engineering science concept of "reliability". The development of high-technology systems does not necessary ensure overall system reliability : even in automated systems human beings often have to play a critical role. So the concept of reliability encompasses two new ideas :

- it is not sufficient to merely define technical performance requirements; it is necessary that organisational structures and global systems allow the development of performance where the management of human beings is important,

- it is important to be able to specify the impact of technical systems on the individual psychophysiological state and any particular effects upon operators in certain specific situations or during certain actions.

In the design and development of new technical systems as in a railway, human reliability increasingly becomes a feature of safety assurance and designers will have greater expectations for information on human performance capabilities.

In considering global safety there is a requirement to collect data on critical events and near misses which come up throughout the network. Detailed examination of those situations and their root causes enable detailed information to be provided for future enhancement of systems-reliability. This structured feedbacke aims at :

. highlighting the inefficiencies, disruptions and incompatibilities within the safety system,

. formulating measures likely to avoid such incidents or reduce their consequences.

In order to meet this target, feedback analysis should identify the human behaviour in its specific railway environment.

FEEDBACK NEEDS TO BE BASED ON INFORMATION AND A PRECISE ANALYSIS OF HUMAN BEHAVIOUR IN ORDER TO DEFINE WHICH WAY COULD BE FOLLOWED TO IMPROVE SAFETY.

This is the reason why the CES has created a model for human behaviour analysis, integrating special items such as the link between the emergence of the incident and the following features:

- **mental strategies and behaviour,**
- **type and impact of local management,**
- **environment ...**

The multifactorial analysis used by the Center of Safety Studies is based upon three elements :

- identifying the weaknesses in the global safety system and describing the relevant human factors issues,
- analysing a failure in human performance within the application of an agreed model of human behaviour
- listening to people and initiating a dialogue with an emphasis on the human factors approach described below in more detail.

Two types of tools have been developed which extensively call upon human science :
- a **MODEL of human behaviour** which provides a framework for considering human error analysis,

- a **DATA BASE** which highlights risk factors influencing safety in the broadest meaning of the word,
These tools are vital to our work.

2. HUMAN FACTORS ANALYSIS SET-UP

The scheme set up is a useful tool to enable each of the disciplines concerned to optimize human performance in the workplace and to contribute to overall system safety. For example the occupational physician is often concerned with :

- individuals' health and behaviour derived from ergonomic studies,
- health-monitoring (both physiological and psychological),
- the appreciation of fitness for work and abilities against given work situations.

Using different but complementary approaches other members of the team (management, personnel, educational, health and safety...) can contribute to making up the overall picture.

The aim is to develop :

. a common approach and common vocabulary so that concepts can be meaningfully exchanged,
. a classification (typology) of failure modes in terms of activities and jobs
. scenarios of events (fault-tree analysis for example) to predict instances where human performance is likely to be critical.

The core of the scheme set up focuses on the following axis :

" ACTUAL EVENTS / HUMAN BEINGS "

As shown in Diagram 1, the real link between events and human beings in the reliability system can be analysed by means of three other axes of analysis :

1 - FAILURE MODE

derived from the characteristics of the event for example :
omission, inappropriate action, too late, too quick...

2 - LEVEL OF FAILURE

In other words the point at which the failure occurs in the information processing chain, e.g.:

detection, interpretation, decision making, motor action...

3 - THE CAUSES FOR FAILURE can be classified as :

- FAILURE MECHANISMS including :

. failure due to habits,
. lack of rigour, non-specific approaches,
. misrepresentation or misperception; relevant information may be perceived but not taken on board,
. under-estimated risk,
. rule violation,
. stereotype takeover,
. communications difficulties or failure,
. distraction,

. vigilance problems or sustained attention,
. lack of knowledge.

- the CIRCUMSTANCES OF FAILURE are threefold :

. the ergonomic requirements of the workplace which may be impaired - for example physiological requirements in information display (e.g sunshine causing glare in the cab); documentation, text and graphical systems, communications,

. matching local organization and technical requirements (organization of the workplace), planning and preparation for work activities in order to optimize

. the situational factors : time pressure, physical environment as noise, thermal environment, extraneous distractors, aggravation caused by customers and the social environment...

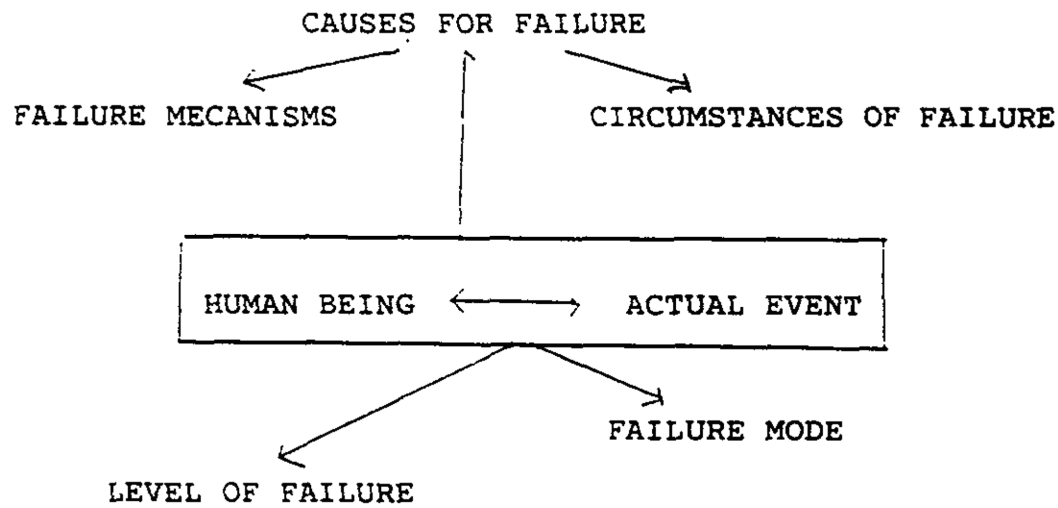

Diagram 1 : HUMAN FACTOR ANALYSIS SET UP
By the Safety Center Studies of French National Railways

The railway situation involves potential dangers which have a bearing on the human behaviour model. The target is to articulate :

- the different levels of information processing (i.e.detection of visual, auditory or other signs, interpretation, decision-making and initiating and pursuing the action),

- and the railwayman's behaviour in a working situation (i.e.that means skill, rule, knowledge) especially the proactive or passive attitude with regard to the railway system.

- From the detection of the above-mentioned signs, the human being applies specific skills. His response can be immediate without any specific analysis of the situation, or delayed with a connotation if , subsequently another sign is perceived or identified as a need to act immediatly. The operator becomes aware of a danger or realizes, consciously or not, that he cannot control the situation. This delay illustrates how individuals evaluate risks by taking into account elements perceived in the nearby environment and identifying them as a change in the technical or organizational system. If the danger always corresponds to the same pattern, operators can make use of the appropriate system-features such as :

. a convention materialized as a physical device (flashing alarm for an immediate danger...),

. a specific training to respond (noise of train approaching or track vibrations...),

. or a memorization of "what-how" or autobiographic events which have led to work difficulties, incidents or accidents.

- The detection of one or more signs simultaneously enables the operator to **identify a problem.** In that case, the incompatibility or unexpected situation must be significant for the railwayman to respond according to a reference rule situation. The main difficulty is to recognize the situation and its characteristic elements. The training must not always place the operator in a well defined situation , but make him consider and analyse what happens and how to appreciate the status of the railway system. The rule must be pursued in a proper way and with all its steps.

- If no rule meets the specific situation, the **knowledge level** is involved and operators call upon analogic and symbolic elements.

These three levels of information-processing involve the reliability of human behaviour in a different way. The analyses made by the CES focus on the need:
. to identify the real cognitive characteristics involved for the railwayman in normal or incidental situations,
. to match the spontaneous attitude of the operator and the global reliability strategy of the company. Lack of knowledge is identified as the problem in 4% of the incidents only, the main problem is WHEN and HOW to use the knowledge and the "what-how". Writing new rules is not the only way to respond to technical strains or organizational factors. It will be impossible to fully improve learning and training if the railwayman does not understand the target, i.e the meaning of his work or the consequence of his non-acting upon the system.

By definition, the application of a rule is fixed, and even if the specificity of a situation suits the condition of use, the operator reduces his cognitive and mental investment, forgetting WHY he is doing THIS ... and the human being spontaneously follows an easy way, this spontaneous attitude, consciously and not, decreases or eliminates some steps. The complexity and to a certain extent the inherent reliability of the railway system make this gap unnoticed. But precisely, the reality of the safety and reliability railway system is built upon these elementary acts integrated in rules and skills. The problem is now to validate the importance of this for operators and managers and to define a specific control upon it.

In order to apply a skill, people unconsciously use the easy route which is the natural way. In classical terms, a good worker is the one who has known his work for a long time. Sometimes, this fact hides an impoverished situation : using preferentially the same skill or applying the same rule, the situation is not exactly the reference one, so the operator has lost his diagnostics capabilities and detection attitude and he is unable to apply the theoretical rule and takes a more appropriate attitude.

The training should not only be geared to the heavy rules or the accident situations, it should describe and make workers respond to the daily elementary actions they have to fulfill.

To be efficient, a skill must be perfectly adapted to the situation and system state. If the worker uses it in an automatic way, the reliability level of the system decreases.

3. ORIGINALITY OF SUCH AN APPROACH

****

This model of human factors analysis is the framework for a DATA BASE which has been created to detect and to highlight risk factors. Taking an overall feedback approach (technical, organizational...), this human factors model is linked with other factors such as scale of severity, danger and accident-scenarios. Its applicability is illustrated by the possibility to focus quickly and efficiently upon the railway system and put an emphasis on the analysis of some items at different steps of its circle life.

The originality of this approach hinges upon the integration of different functions within the organization :

. the team of CES specialists has developped their knowledge and understanding of human factors,

. the company has highlighted its weaknesses in terms of human behaviour and overall system-reliability,

. the technical departments have increased the efficiency of their projects by reflecting nationwide targets into their requirements,

. trainors are able to incorporate this new information into their educational strategy.

4. PRACTICAL PERSPECTIVES

****

An integrated approach to prevention spans the whole entreprise.

Human reliability developments in the particular context of a rail system are focused on practical points :

A better understanding of human performance **enhances operator's competence, helps to maintain human performance-levels**, especially in emergency situations.

In incident and accident scenarios, we have noticed an important gap between the theorical and actual cognitive level of information processing.

This gap is very frequent and concerns a lot of activities : in most cases, operators use rule attitude in which the effect of daily work has lessened the level of reliability.
This gap also depends on the activity, for example :
the electric signalling maintenance operators do not apply the skill described in procedures, in spite of recent modifications, and stay at a rule-based level or a knowledge based level which decreases the system reliability. Human factors analysis is very helpful to understand "why ? " and " How to rectify that ? ".

MANAGEMENT

Such information is applied by managers to adapt their daily management-approach and prevent such behaviour deviation.

The understanding by managers of the global safety system appears insufficient. The preventive solutions tend to focus too much upon specific points rather than towards a system approach.

The managers do not lay sufficient emphasis on the significance of the simple daily attitudes and minimize their relevance during the monitoring.

TRAINING

At the same time, the trainors must demonstrate the importance of each simple action within safety tasks. A national study is conducted to identify the assessment of each kind of primary and other training upon individual safety management. One objective of this analysis is to specify the type of memory and information-processing pattern used by operators for decision-making in real situations.

DESIGN AND ERGONOMICS

An awareness of near misses and incidents is developped in order to specify the design, development of implementation and the operability of new systems, and to create adapted guidelines for feedback integrating all the useful details.

SAFETY LEVEL ASSESSMENT PREDICTIONS

By this feedback analysis, an improved dialogue between specialists of human factors, managers, trainers, and users has showned the difficulties faced by railwaymen. In that way, it is possible to anticipate the identification of weaknesses and to develop a prevention-policy.

INVESTMENT DECISIONS

Risk prevention requires investment to be made in the technical and fonctionnal system, training and specific management of human beings, while considering the most efficient impact upon global railway system.

Therefore, the statistic feedback information is connected to the qualitative assessment of human behaviour and its consequences upon the railway cycle life.

QUANTIFICATION

The Human Factors analysis set-up gives us a possible quantification of the impact of human behaviour upon the safety of the railway system and it is studied by the CES in conjunction with RATP, as it will be explained in a next paper.

CONCLUSIONS

****

By its investigation of human behaviour, the Center for Safety Studies is developing, on behalf of SNCF, a core of expertise and an unique knowledge base in the areas of human reliability and safety.

The detailed analysis conducted on the basis of the human behaviour model provides guidelines for prevention and safety prioritization purposes.

Increasingly, this data indicates performance shaping factors in the railway environment and facilitates other studies such as risk perception by individuals.

The quantitative assessment of railway performance shaping factors should be increasingly developped in the near future as well as the cooperation between engineers, technicians, ergonomists, occupational physicians and other specialists in order to identify problems early and to improve risk-management plans.

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International Rail Safety Conference

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9317

David Maidment

Safety Management Training

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

SAFETY MANAGEMENT TRAINING

David MAIDMENT

Head of Safety Policy Unit
British Railways Board

International Railway Safety Conference, Angers 1993

SAFETY MANAGEMENT TRAINING

Paper by David Maidment, Head of Safety Policy Unit

British Rail.

Introduction and Background

Until 1990, most BR safety training was skill-based or vocational and allied to the specific tasks to be done, or to rules/technical standards that the "trainee" was required to understand and implement.

Following the Clapham accident, BR commissioned the Du Pont organisation to review its Safety Management Systems and one of the key recommendations adopted by the Board was a formal and comprehensive programme of safety management training for all management and supervisory staff.

Training Content Philosophy

The recommendations made and the training courses developed were based on a number of key principles:

1. Employee and Passenger/Product safety were based on acquiring similar attitudes and behaviour, and should be addressed together.

2. Managing safety was a basic role of management, and should be integrated with other key commitments of managing finance, quality etc

3. Safety Management was process and not rule-based.

4. Good safety was grounded in competent and proactive management creating the systems and environment in which operations could be safely carried out.

5. British Rail needed to develop a new safety management culture.

Subsequent developments in Safety Management on BR have highlighted the core beliefs that the systems should be "risk-based" (identification, analysis and evaluation, reduced, controlled, monitored) and people-orientated (attitudes, involvement, responsibilities, motivation and reward).

Development of BR Safety Management Training

Initially, the Safety Directorate called a conference of business and functional representatives to identify safety training needs, and, after establishing what was already available, or could be built on, established priorities.

The principle adopted at the June 1990 Conference was that "core" safety management courses should be developed for Strategic Management, Executive Line Management (down to supervisory level), with subject variants to ensure relevance to participants. These courses would be mandatory, with optional specialist modules available for developing further safety management skills.

Documentation of some of the BR Safety Training policy development is attached:

Notes of the 1990 safety management training conference.

Extract from BR's formal "Safety Management Programme" initiated in July 1990, incorporating the first safety training proposals.

Description of some of the key "core" and "module" training courses developed by the Safety Directorate, as presented to the UIC "Ad Hoc" Group on Occupational Health and Safety following their June 1993 meeting.

Delivery of the Programme

After development, the Safety Directorate made the courses available for delivery by the Businesses, using in-house training staff, safety specialists, or training/safety consultants, as appropriate.

The Safety Directorate itself retained delivery, in conjunction with consultants, of the Strategic Safety Management Course, as the accreditation of top management teams became a mandatory element of BR's safety validation process applicable to all new organisational proposals, before implementation. Accreditation involved assessment by the course tutors, and an examination. Some 800 senior managers, right up to Board level, have obtained the Certificate of Accreditation.

The Course is now being reviewed in the light of safety management developments over the last two years, the requirements of privatisation, and the policy of developing training "competencies" for all safety critical staff through the "National Council for Vocational Qualifications" (NCVQ) body. The key units essential to acquire the necessary competency are outlined in the attached draft document. For managers with safety duties and/or responsibilities, competence will have to be demonstrated in the appropriate work environment, as well as on the course.

The "Foundation" Safety Management Course has also been updated to incorporate some of the elements of safety audit, loss control and risk management that are now core to the business. This has been undertaken by one of the Passenger Businesses (Network SouthEast), and made available to all BR management staff.

Conclusion

The BR Board, through the Safety Directorate and Training organisation, in collaboration with the businesses, keeps the programme continually under review. Other courses, suitable for particular groups of staff, or to meet specific needs, (eg new legislation) on a temporary basis, are developed by the Businesses, as appropriate, with specialist safety advice.

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Front line employees - trackside staff, signalmen, drivers, etc - receive vocational skill training, which is being developed as part of the NCVQ (competencies) programme. However, most importantly, issues of involvement and culture are being addressed through the policy of involving all BR staff in regular (usually monthly) safety meetings (a cascade of meetings of manager plus direct reports, including group supervisors and workface employees).

A programme of videos is now under development to use as the "core" material for next year's safety meetings, addressing in suitable form, BR's understanding of risk and human error. This is being prepared in close association with the Safety Directorate's "Human Factors" expertise and the University of Manchester (Professor Jim Reason) using the video presentational skills of the firm that developed Shell International's safety training, founded on the same safety philosophy.

D J Maidment
Head of Safety Policy Unit

September 1993

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SAFETY MANAGEMENT PROGRAMME TRAINING STRATEGY

Introduction

The Training Strategy Conference (14/15 June 1990) was held to address the issues of safety management training Principal considerations were:

- The need for safety training for all BR staff identified by various reports
- The need to produce a structured programme to avoid a fragmented approach.

Representatives from Regions and Functions attended the conference and opinions were sought from H.Q. organisations prior to the conference taking place.

The following safety training needs have been defined.

- **A Core Safety Management Training Programme**

  This programme would be for all management staff and should also be used as part of the induction course for new members of management and supervisory grades.

- **Core Variants**

  A series of modifications to the core, customising it to meet the needs of specific categories of management.

- **A "Safety Professionals" Training Programme**

  Designed specifically to reach necessary levels of expertise it will use, as far as possible, recognised external training to qualification/certification. These specialists will need the Core programme for line management so that they are aware to the attitude/cultural issues involved.

- **Specialist Safety Training Modules**

  These will cover specific areas of expertise and will be additional programmes to the Core for individual staff when appropriate.

A **Project Team** is being set up with the production of the Core programme as its first priority, followed by five modules (Hazard Identification, Emergency Procedures, Audit, Communications – safety briefing and Accident Investigation, reporting and analysis).

The Project Team will need to take into account safety initiatives under way, the availability of existing materials and the likely numbers requiring the different programmes.

SAFETY MANAGEMENT PROGRAMME TRAINING STRATEGY

Prospectus

Core Safety Management Programme

Attitude/culture change
Personal safety responsibilities
Establishing standards
Health and Safety legislation
Enforcement agencies
Introduction/overview of modules

Core Variants

Line managers and supervisors
Office staff
Building management
Design/project management
Support functions (Business, Finance, Personnel)
Road transport management
Catering management
International management

Safety Professionals

External courses available

Specialist Modules

Hazard identification
Emergency procedure and mishap management
Audit
ISRS audit system
ISRS appreciation
Communications – safety briefing
Union liaison/machinery
Organisation – roles and structure for safety management
Manaement of contractors and suppliers
Risk assessment techniques
Accident investigation – reporting and analysis
Safety system analysis including job task analysis
Fire training
Safety of third parties
Coping with conflict and assault
Track safety
New legislation (as appropriate)

Safety Management Programme

1. Strategic Safety Management Course

Introduction

This key course is designed to equip Senior Managers with the knowledge necessary for them to fulfil successfully their safety responsibilities.

Who Should Attend?

Attendance on this Course is by invitation from the Director, Safety in accordance with the Board's policies. It will normally include Headquarters Business Directors, Profit Centre Directors, their immediate reporting responses and other specified Senior Managers. It is essential that those attending should have strategic, rather than tactical safety responsibilities.

Aims

The course has been designed to:

- ❑ Provide full awareness for Senior Managers of BR safety expectations
- ❑ Supply the necessary background knowledge to assist Managers in carrying out their safety responsibilities
- ❑ Give an opportunity for Managers to practise the skills necessary to fulfil their safety role successfully
- ❑ Familiarise Managers with the Foundation Course in Safety Management

Safety Management Programme

Objectives

At the end of the course Managers will be able to:

- ❑ List their safety responsibilities
- ❑ List the resources they require to meet their safety responsibilities
- ❑ State BR's definition of safety
- ❑ State BR's view on senior management's responsibilities in safety
- ❑ Describe the principles of safety management
- ❑ List those aspects of BR's business for which they have safety responsibility
- ❑ Describe in quantitive terms what BR is trying to achieve in safety
- ❑ Translate qualitative safety goals into quantitative objectives
- ❑ List the main items of safety law applying to BR
- ❑ Describe the main sources of BR safety standards
- ❑ Describe the principles of hazard control
- ❑ List the main stages in a hazard identification inspection
- ❑ Describe the principles of safety monitoring and the role of outcome data
- ❑ Describe the principles of management and safety auditing
- ❑ Design a relevant segment of a management audit
- ❑ Describe the main stages in management and safety auditing procedures
- ❑ Describe the role of auditing in the monitoring procedure
- ❑ List the main features of an adequate safety policy
- ❑ Design strategies and tactics for achieving relevant safety objectives
- ❑ Describe the safety monitoring data available in BR and the uses to which they are put

Safety Management Programme

Method

The course is based around group and syndicate work. Delegates will be expected to complete a workbook and take an examination.

Expert assessment will be carried out over the full period of the course and delegates will need a pass in each aspect to achieve certification.

Training Period and Venue

This is a 3 day residential course. It will normally be held at a quality hotel in the home counties.

Pre-Course Preparation

Delegates should establish their precise responsibilities for safety before joining the course

Course Arrangements

This course is centrally funded and is administered by the Director, Safety. A senior member of the Safety Department will be in attendance, both to provide input and obtain feedback. A Course Manager will also attend to look after the administrative requirements.

2. Foundation Course in Safety Management

Introduction

This Course is the foundation on which the knowledge of safety management will be built.

A series of supplementary 'modules" will be developed in support of this course. These will cover specialist activities or responsibilities or will provide more detail and information on subjects introduced in the Foundation Course.

Who Should Attend

The Course is designed for all Managers and Supervisors with line responsibilities for safety in the workplace which could involve staff, customers, public, premises, equipment and systems of work.

Business, Profit Centre, Corporate and Central Services Managers are responsible for defining which individuals should attend. This should be structured over a five year period on the principle that Managers attend before their subordinates.

It is intended to develop variants of this Course for specific disciplines. Those variants identified are outlined in the Training Strategy, Section 'H' of the Safety Management Programme. Managers should identify whether the Foundation Course or a variant is appropriate for their staff, seeking advice from the Director, Safety's training team as necessary.

Aims

The course has been designed.

- To introduce attendees to the renewed commitment to safety within BR
- To provide attendees with the knowledge necessary to identify and meet their safety responsibilities
- To help attendees appreciate that safety is integral to all that they do
- To make everyone aware that there are effective means of managing safety

Safety Management Programme

Objectives

At the end of this Course Managers and Supervisors will

- ❑ Be able to list the range and particulars of their safety responsibilities and identify the resources necessary to meet them
- ❑ Be aware of the range and nature of legislative and BR standards and identify the requirements relevant to their own safety responsibilities
- ❑ Be familiar with a range of common hazards and have increased their ability to identify new and uncommon hazards
- ❑ Understand the techniques of assessing and managing risks, and the importance of selecting appropriate control measures
- ❑ Be aware of the importance of monitoring and the main monitoring techniques
- ❑ Be able to meet their safety responsibilities in a cost effective manner, integrated into their many and diverse daily tasks

Methods

The course involves a study by participants of the safety standards within their own area of responsibility, together with course work, completion of a workbook and a formal written examination.

Assessment will be carried out and it will be necessary to achieve an appropriate standard in each course aspect in order to receive certification.

Training Period and Venue

The Course consists of 2 single days separated by approximately 6 weeks during which time some 18 hours of workplace study and application will be required in the delegate's own environment. It is essential, therefore, that time is made available by the participant's immediate Manager.

The Grove Management Centre will administer the Course which will be held at quality hotels around the UK.

Safety Management Programme

Pre Course Preparation and Post Course follow up

Considerable emphasis is placed on both these aspects.

Pre-Course - A full discussion between candidate and immediate Manager to agree the scope and particulars of the individual's responsibilities.

Post-Course - The Manager will agree a personal action plan with the successful participant, based on their agreed responsibilities and the skills and knowledge gained on the course.

Course Arrangements

Applications should be made to The Grove.

The costs of the development of the course have been borne centrally by the Board but the running costs, including release costs and payments to The Grove, are the responsibility of applicants. They are, however, recognised as part of the safety expenditure of functions/businesses and, as such, any expenditure incurred in attendance at this Course should be submitted to the Safety Panel through the normal submission procedures.

SAFETY MANAGEMENT PROGRAMME

3.1 Hazard Management Course

Introduction

This Course is one of a series of supplementary 'modules' prepared in support of the Foundation Course in Safety Management. It provides detailed information on one specific topic.

Who Should Attend

The Foundation Course provides a grounding in hazard management (i.e. of both unsafe acts and unsafe conditions) and Managers should determine whether it is appropriate to supplement the basic training given to Managers and Supervisors in the Foundation Course, with this more comprehensive module.

The module is perhaps appropriate to the more senior members of the local management unit with defined areas of control. Those Managers who are required to inspect workplaces on a regular basis with a view to identifying, correcting and controlling unsafe acts and conditions, or local Safety Advisors, would benefit from attendance.

Aim

This Course has been designed to prepare attendees to manage hazards effectively.

Objectives

At the end of this Course, Managers will:

- ❑ Be able to identify the hazards which exist in the workplaces under their control
- ❑ Have learnt and practised different methods of identifying various hazards
- ❑ Have developed the necessary techniques to manage and control hazards
- ❑ Understand the causes of hazards - in particular the relationship between unsafe conditions and unsafe acts
- ❑ Understand how to eliminate hazards from the workplace and all its systems

Safety Management Programme

Method

The Course is based around visits to typical BR workplaces supported by syndicate work and completion of a workbook. Final workplace assessment, however, will be undertaken on an individual basis.

Throughout the Course attendees will be under the control of tutors and escorts. (*Note* whilst on workplace visits full interaction is encouraged with the workplace staff, but not at the expense of safety or productivity)

The Course is completed by a half hour written examination.

Assessment throughout the Course, together with the successful completion of syndicate work, the workbook and the examination, will result in certification.

Training Period and Venue

This is a 2 day Course, split between workplace visits and course work in suitable adjacent training accommodation The Courses will be mounted in appropriate locations throughout the UK.

As detailed in the introduction, this Course supplements the Foundation Course in Safety Management. Candidates should, therefore, have previously attended the Foundation Course.

Post Course Follow-Up

For this course an assessment form has been prepared for both the candidate and the nominating Manager.

This should be completed to ensure that the Course meets the needs of the user and also retains its auditable status.

Course Arrangements

Until the middle of 1991 the Course will be administered by the Director, Safety. After that time, it will be managed by The Grove and applications should be made to the Management Training Centre.

The costs of the development of the Course have been borne centrally but the costs of any residential accommodation, payments to The Grove and release costs are the responsibility of delegates. They are, however, recognised as part of the safety expenditure of functions/businesses and, as such, any expenditure incurred should be submitted to the Safety Panel through the normal submission procedures.

BRITISH RAIL - ANALYSIS OF SAFETY MANAGEMENT TRAINING

1. STRATEGIC SAFETY MANAGEMENT COURSE

WHO?	WHAT?	HOW?	WHERE?	HOW LONG	WHO BY?
All Senior Line Managers, Business Teams (600-800 Managers within BR). Certification required by BR Board for all Managing Directors and their Teams. Also Profit Centre (Route Directors) and teams. Essential part of Safety Validation.	Basics of safety management principles - Responsibilities - Legal Duties of Care - Safety Policies & Plans - Objective setting - Action Plans & Resources - Safety Audit Systems - Safety Measurement - BR Policies on:- Risk Management Human Factors - Risk Identification	Lectures Tutorials Discussion Syndicate Work Workbook used by participants to apply principles to own work responsibilities. 1 hour exam and formal accreditation	High class Hotel with Conference room for 15-20 people plus 3 syndicate rooms. Residential.	3 days full time including evenings.	Consultants ([illegible]M) - 2 [illegible] time lecturers, including Professor of Safety Science Unit, Aston University, with input by BR lecturers, including final session with a Board Member.

BRITISH RAIL - ANALYSIS OF SAFETY MANAGEMENT TRAINING

2. FOUNDATION COURSE - SAFETY MANAGEMENT

WHO?	WHAT?	HOW?	WHERE?	HOW LONG	WHO BY?
Line Managers with executive Safety responsibilities, including Station/Depot Managers, and Senior Supervisors. (Up to 10,000 Managers and other planned over 5 year period).	Basics of Safety Management, broad syllabus as for Strategic Safety Management, with emphasis on identifying our responsibilities, law, basic risk identification, mitigation and development of action plans.	Classroom lectures and syndicates, then practical application in the workplace, returning for further formal training, feedback discussion of experience. Workbook. 1 hour exam.	Hotel or Railway Training School. (15-20 participants per course).	Two x 1 day modules split by 6 weeks in own job, requiring 3 days devoted to application of theories and completion of Workbook.	Course designed by Consultants (HASTAM) and delivered by individual Businesses, using (i) Consultants contracted by themselves or (ii) BR Grove Management Training School or (iii) In-house tutors.

BRITISH RAIL - ANALYSIS OF SAFETY MANAGEMENT TRAINING

3. PROJECT SAFETY MANAGEMENT COURSE

WHO?	WHAT?	HOW?	WHERE?	HOW LONG	WHO BY?
All Project Managers and Project Engineers appointed to major investment scheme management, including construction.	Strategic Safety Management Course, amplified to cover more extended sessions on:- Risk Management Management of Contractors Law concerning major construction projects producing Project Safety Plans and Safety Strategy.	Lectures Tutorials Discussion Syndicate Work Workbook used by participants to apply principles to own work responsibilities. 1 hour exam and formal certification.	High class Hotel with Conference room for 15-20 people plus 3 syndicate rooms. Residential	5 days including evenings.	HASTAM designed course adapted by BR Safety Directorate for Director, Projects Delivered by Consultants on contract to Director, Projects

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BRITISH RAIL - ANALYSIS OF SAFETY MANAGEMENT TRAINING

1. RISK MANAGEMENT APPRECIATION COURSE

WHO?	WHAT?	HOW?	WHERE?	HOW LONG	WHO BY?
Senior Business Managers and Engineers who need to consider commissioning of major Risk Assessment Studies. (Available to Businesses, but not mandatory).	Principles of Risk Assessment, Analysis and Management. Techniques available - HAZOP - Fault Trees - Event Trees - FME(C)A Safety Cases Application lessons Examples BR policy on Risk Management	Lectures and tutorials Case Studies Workbook Examination to provide accreditation.	High class Hotel Conference Room (15-20 participants) Residential	2 days full time with one evening.	Course designed and delivered for BR by A.D.Little. Delivery now being organised by Businesses, using Consultants (most using A.D.LITTLE HASTAM OR TRANSMARK) plus BR Safety Directorate tutors.

BRITISH RAIL - ANALYSIS OF SAFETY MANAGEMENT TRAINING

RISK ASSESSMENT FOR LINE MANAGERS

WHO?	WHAT?	HOW?	WHERE?	HOW LONG	WHO BY?
Line Managers and Senior Supervisors (Depot/Station Managers etc.) (Not mandatory)	Simple Risk Assessment using basic Quantified Risk Assessment techniques, HAZOP Fault Trees Event Trees Hazard identification FMEA	Lectures, Syndicate work, case histories and subsequent workplace projects.	Hotel, with some follow-up in own workplace.	3 days with pre- and post-course work.	Syllabus designed by A.D.Little at Safety Directorate request. Delivery by Businesses (most use Consultants).

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BRITISH RAIL - ANALYSIS OF SAFETY MANAGEMENT TRAINING

HAZARD MANAGEMENT AND CONTROL

WHO?	WHAT?	HOW?	WHERE?	HOW LONG	WHO BY?
Managers and Supervisors with responsibilities for workplace safety.	A module building on Foundation Course. Practical identification of common hazards and loss control techniques. Inspections of workplace and simple evaluation (frequency x severity) of risk.	Some classroom work, but several practical exercises at work locations. Exam.	Hotel with location training in railway facility near hotel.	2 days (1 night residential)	First 600 managers trained by Consultants (HASTAM) who designed course. Thereafter delivered by Businesses for own staff, using In-house trainers or Consultants.

BRITISH RAIL ANALYSIS OF SAFETY MANAGEMENT TRAINING

'. OFFICE SAFETY MANAGEMENT

WHO?	WHAT?	HOW?	WHERE?	HOW LONG	WHO BY?
Managers and Senior Administration Staff whose responsibilities are for office-based staff.	A variant of the Foundation Course in basic Safety Management principles, using office based examples, responsibilities.	Lectures, Syndicate work, and subsequent workplace projects.	Hotel with follow-up in own workplace.	2 days with pre and post course work.	Delivered by Businesses, using in-house trainers, consultants or BR' Central Services (self financing Safety Services Group).

BRITISH RAIL - ANALYSIS OF SAFETY MANAGEMENT TRAINING

3. MANAGEMENT OF CONTRACTORS

WHO?	WHAT?	HOW?	WHERE?	HOW LONG	WHO BY?
Managers and Supervisors controlling Contractors' staff.	Legislation on Management's responsibilities for Safety of Contractors Case Law and interpretation Development of Safe Systems of Work Audit and monitoring systems.	Lectures and discussion, with subsequent project work in own workplace.	Hotel or BR Training School or BR Conference Room with subsequent work in own workplace.	1 day with pre- and post-course work.	Developed on behalf of Safety Directorate, delivered by Businesses using In-house trainers, Central Services (Consultants

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9318

David Wharton-Street
Ms Sarah Tozer

A proactive system for measuring organisational safety health in a railway environment ("REVIEW")

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

A PRO-ACTIVE SYSTEM FOR MEASURING ORGANISATIONNAL SAFETY HEALTH IN A RAILWAY ENVIRONMENT ("REVIEW")

David WHARTON-STREET

Human Factors Adviser
Safety Policy Unit
British Railways

Sarah TOZER

Ergonomist
Research Division
British Railways

The paper will be presented by Sarah Tozer, Ergonomist in the Human Factors Research Department and David Wharton-Street, Human Factors Adviser in British Rail's Safety Policy Unit.

The Paper is based on research sponsored by British Rail with Professor Reason in the Department of Psychology - University of Manchester.

The concept in the Paper addresses organisational safety health in a Railway environment by identifying potential active and latent failures prior to a damaging event. This is achieved by the use of a pro-active measuring system involving safety critical staff, supervisors and managers.

The measuring system encompasses organisational pathogens and core processes expressed as sixteen Railway Problem Factors.

D K Wharton-Street
Human Factors Adviser

INTRODUCTION

The Railway systems in Britain suffered two major incidents in the 1980's. The Clapham train crash involved three trains on a heavily used section of railway near to London's southern terminal. The cause was a bare wire in an electrical circuit controlling the colour aspect of a signal. The signal displayed a 'wrong-side' failure (ie green aspect when it should have displayed 'red') and as a result, a heavily-loaded commuter train ran into the rear of another train. Thirty five people were killed and 484 injured.

The Kings Cross accident occurred on the London Underground when an accumulation of debris underneath an escalator caught fire from the careless dropping of lighted smokers material. The resultant fire swept through the confined spaces of underground escalators and ticket hall killing 31 people.

The British Government instigated formal investigations in both instances and a list of recommendations was published by the Chief Justice in charge. The recommendations are named after the Chief Justices - 'Hidden' for the Clapham train crash and 'Fennel' for the Kings Cross Fire.

The Clapham and King's Cross inquiries revealed that railway accidents can have long histories. They may be in the making for years, even decades. The wiring error and the dropping of lighted smoker's material were the final links in a long chain of events involving the insidious accumulation of latent failures within these two railway systems. As such, they were both organisational accidents, each involving contributions from many parts of the total system.

Latent figures are not unique to railway operations. They are common to all complex, well-defended and potentially hazardous systems and played an equally significant part in other international incidents:-

- the nuclear emissions at Three Mile Island and Chernobyl,
- the sinking of the Channel ferry of Zeebrugge.
- the chemical release at Bhopal in India.
- the explosion and disintegration of the US Challenger manned rocket and spacecraft.
- the explosion on the North Sea oil rig 'Piper Alpha'.

In the past, railway accident investigations tended to focus upon the active failures of those at the sharp end. The spotlight was upon the errors and violations comitted by drivers, shunters, track workers and others in direct contact with hazards. These unsafe acts usually had an immediate adverse impact upon safety and were the direct causes of any accident. Remedial efforts were then directed at preventing the recurrence of these particular actions through engineered safety measures, amendments to the Rule Book and other containment measures.

The organisational accidents of the 1980s have taught us that the people at the sharp end are more often the inheritors rather than the instigators of accidents. If we are to continue improving the safety of the railways through the 1990s and beyond, we must develop effective techniques for identifying and eliminating latent human failures before they contribute to accidents. This means taking regular measurements of the organisation's "vital signs". REVIEW offers a convenient and practical way of making these "health checks".

WHAT IS REVIEW

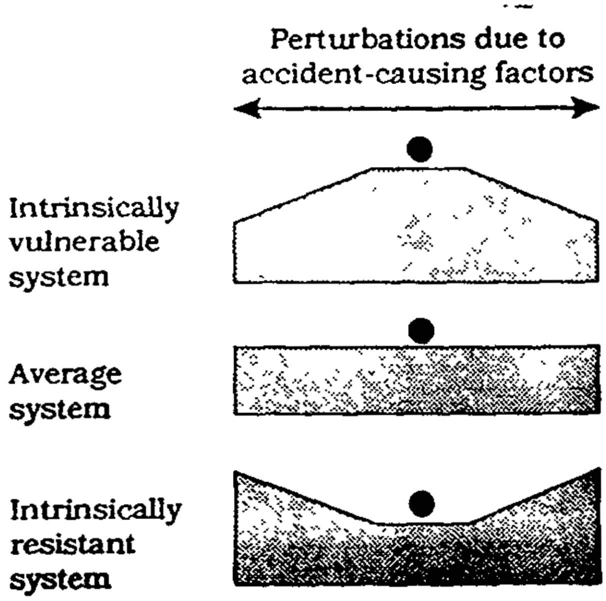
REVIEW has two main components.

> A principled way of thinking about accident causation and about the nature of safety that leads to the setting of achievable long-term safety goals.
>
> A set of diagnostic instruments for making visible, within a particular railway activity, the organisational and situational factors that lead to unsafe acts and accidents.

REVIEW assumes that the principal focus of future safety management should be the human factor. Human decisions and actions play the leading role in nearly all accidents. This is not a question of malevolence or incompetence, merely of opportunity. The railway system is designed, constructed, operated and maintained by people.

Getting things wrong is an inescapable part of the human condition. We can moderate human error but we can never eliminate it completely. The same is also true for the hazards inherent in railway operations. Human flesh will always come out worst in contact with heavy metal. This means that we will never achieve absolute safety. The only attainable goal is to make the system as a whole as "healthy" as possible.

What does it mean for a system to be "healthy"? It means being intrinsically resistant to the accident-producing factors that are an inevitable part of railway operations. This idea is illustrated in Figure 1.



Fugure 1 Illustrating three levels of "safety health"

Consider a ball-bearing lying on a milled steel block. In the top picture (see Figure 1), it would require only a small disturbance (from the accident-causing factors) to push it over the edge. In the middle picture, showing an average system, the ball has further to go before it reaches the edge, but there is still little or no resistance offered, since it lies on a rectangular block. Only in the lower picture does the system as a whole have intrinsic resistance to the various perturbations. To get the ball over edge requires a much greater force due to the upward sloping surfaces. Notice, however, that it is still possible for it to be pushed over the edge. Even resistant systems do not possess total immunity to accidents.

Accidents, by definition, are uncontrollable. Too many of the causal factors lie outside the control of the system managers. Chance, Murphy and Sod's Law all play a major part in any system breakdown.

REVIEW assumes that the only attainable goal in safety management is to achieve the maximum intrinsic resistance to accident-causing factors and then to sustain it. Safety management is thus equivalent to maintaining a continuous fitness programme. It should not be, as it is in many organisations, a kind of reversed production process that strives to bring the accident figures down to some acceptable target level.

Safety is a management problem. Any kind of management depends critically upon having the right information at the right time. But the many defences that have evolved over the long history of railway operations, together with the implementation of many "good safety practices", have brought British Rail to the point where negative outcome data (derived from accidents, incidents, etc.) are too sparse, too late and too statistically unreliable to support effective safety management. Railway management have tended to react to accidents, not to identify possible causes in advance of incidents.

REVIEW is a "health" monitoring tool that exploits the positive rather than the negative aspects of safety. It focuses upon a particular activity (i.e., shunting, track maintenance, driving, signalling, etc.) and generates proactive measures of its intrinsic resistance to combinations of fallible decisions, unsafe acts and breached defences. The problems so identified then become the targets for immediate improvement. In this way, limited resources are deployed in the most effective manner.

WHAT REVIEW IS NOT

REVIEW is not safety "add on". It is not just a safety management tool. It samples many aspects of system quality. As such, it forms part of any railway manager's essential tool bag.

REVIEW does not replace existing safety measures. It is designed to supplement rather than supplant them. Indeed, a prerequisite for its application is that these "good practices" such as a Safety Management system and Safety Meetings with Staff are already in place.

REVIEW is not another bought-in safety package. It has been created within British Rail specifically for BR activities by a research group from the Human Factors Team in Director Safety and BR Research, Derby and the Department of Psychology, University of Manchester. **REVIEW** depends critically upon the knowledge and experience of those who now run the railways. It is a bottom-up rather than a top-down device. REVIEW is both built and owned by those who use it.

IMPLEMENTING REVIEW

This section describes the measuring and targeting functions of REVIEW. It also explains the principles underlying these measurements.

REVIEW'S AIMS - THE 16 RAILWAY PROBLEM FACTORS

REVIEW is designed to provide "soft" quantification of the extent to which 16 Railway Problem Factors (RPFs) have an adverse impact upon railway activities. The RPFs were identified by asking a wide variety of railway personnel to list the human factors problems associated with the Design, Build, Operate and Maintain aspects of railway functioning. The selected RPFs represent the most frequently cited problem types. As such, they can be regarded as generic to all railway activities. These factors are listed below:

- Tools and equipment
- Materials
- Supervision
- Working environment
- Staff attitudes
- Housekeeping
- Contractors
- Design
- Staff communication
- Departmental communication
- Staffing and rostering
- Training
- Planning
- Rules
- Management
- Maintenance

*(Itemised descriptions of these RPFs are given in Appendix I.)

DATA HANDLING AND INTERPRETATION

In order for these data to reach the right people in an easily interpretable form, it is necessary that REVIEW should be able to provide selected safety indicators (profiles), broken down in a variety of ways:

- by grade of assessor (i.e., supervisory or managerial)
- by functions and activities (i.e., signalling, shunting etc.)
- by Railway areas (i.e.,Doncaster,Newcastle,Edinburgh,etc).
- by business units (i.e., East Coast Main Line)
- by businesses (i.e.,InterCity)

CONSTRAINTS UPON THE ASSESSMENT TASK

To enable these assessments to produce valid indications of the safety and quality "health" of a particular function, area, etc., it is necessary that they should satisfy a number of criteria. These are listed below.

- For any single individual, the assessment task must be simple, obviously relevant and short. This means the assessments must be made in relation to the performance of a specific job over a particular period of time, say a month.
- The "paper burden" must be kept to a minimum.
- To compensate for idiosyncratic judgements, the profile must be derived from several people (where that is possible).
- The **REVIEW** package must be capable of providing selected breakdowns and trends at any time with the minimum of administrative time, cost and effort.

The only way all of these criteria could be met was by implementing **REVIEW** as a software package, designed to work on stand-alone or networked PCs. It was therefore decided to fashion this assessment package in the form of a simple grid.

THE REVIEW GRID

The basic form of the **REVIEW** grid is shown in Figure 2. The columns reflect the activities and functions carried out within a particular area. The rows provide the means of assessing the extent to which any one of the 16 RPFs contributes adversely to the work carried out by a particular function.

Totalling the cell values over single columns or over all columns will give profiles for each function or area respectively. Totalling down the columns will give a rough indication of the extent to which each activity or function has attracted problems.

Each column may be entered by a variable number of people (according to their work). On each assessment occasion, the individual is asked to judge the extent to which each factor has been a problem in carrying out his/her job over the past month. The judgements are made on a 5-point scale, where 1 = no problem at all, and 5 = a serious problem.

The **REVIEW** program yields running average profiles over time by accumulating the ratings of individual people for a particular area or function. Clearly, it will be necessary to put a limit on the life of the data within the program. Time-expired data will be archived and remain available for calculating trends, but it will not contribute to the current running average.

Figure 3 gives an example of how the **REVIEW** program may be implemented within the East Coast Main Line.

Railway Problem Factors (RPFs)	Activities & Functions				
	Track-related	Signalling	Overhead lines	Driving	Shunting
Tools & equipment	1-5 ratings	1-5 ratings	1-5 ratings	1-5 ratings	1-5 ratings
Materials	1-5 ratings	"	"	"	"
Supervision	1-5 ratings	"	"	"	"
Working environment	1-5 ratings	"	"	"	"
Staff attitudes	1-5 ratings	"	"	"	"
Housekeeping	1-5 ratings	"	"	"	"
Design	1-5 ratings	"	"	"	"
Staff communication	1-5 ratings	"	"	"	"
Dept. communication	1-5 ratings	"	"	"	"
Staffing & rostering	1-5 ratings	"	"	"	"
Training	1-5 ratings	"	"	"	"
Planning	1-5 ratings	"	"	"	"
Rules	1-5 ratings	"	"	"	"
Management	1-5 ratings	"	"	"	"
Contractors	1-5 ratings	"	"	"	"
Maintenance	1-5 ratings	"	"	"	"

Figure 2 Showing the main features of the REVIEW grid

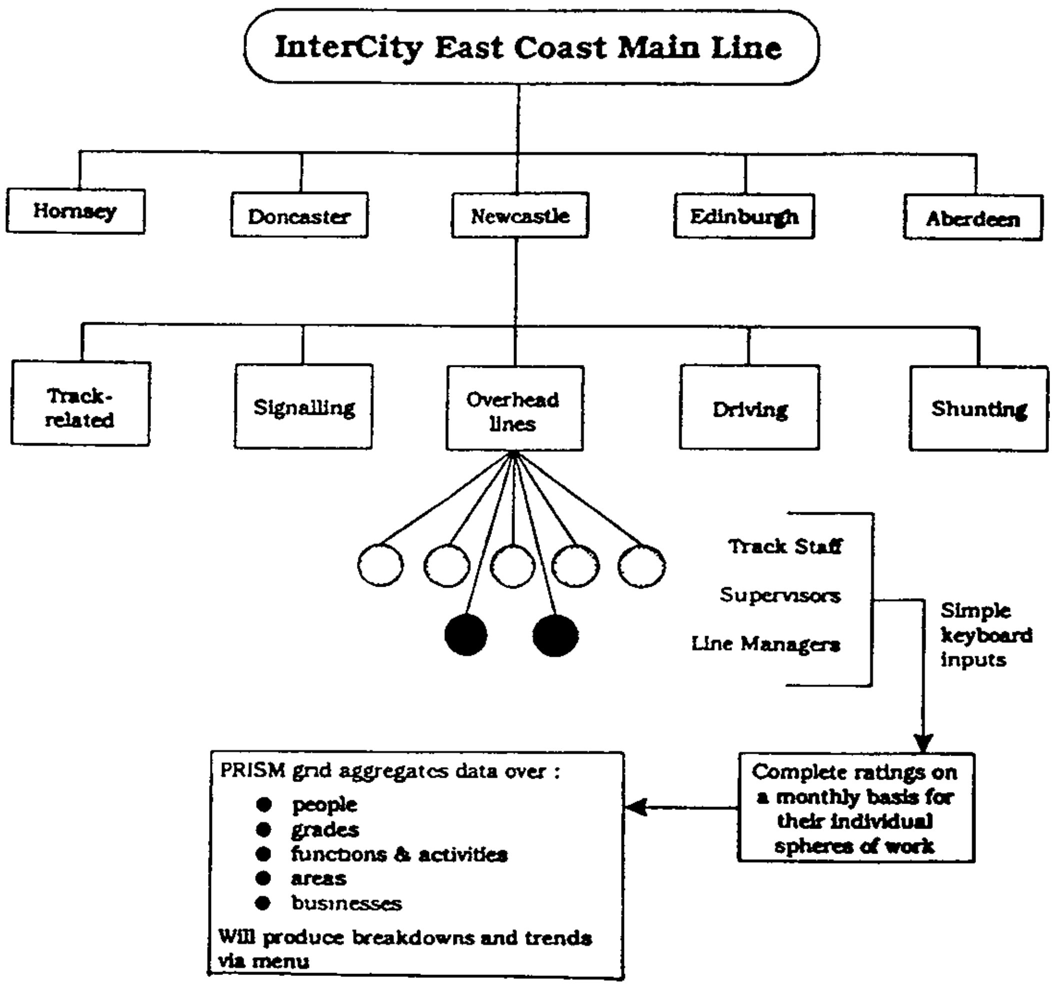


Figure 3 Summarising how REVIEW might be implemented on the East Coast Main Line

IDENTIFYING "BAD" RPFs

The aim of the **REVIEW** program is to identify 2-3 RPFs currently in need of urgent remediation. Improving these becomes the attainable safety goal for some defined period of time. How they should be improved is a matter for the relevant management and staff.

Since the profiles will be derived from averaging data over people, grades, functions and areas, there will be a tendency for profiles to flatten out as more and more data is included. Of particular interest is the degree to which given RPFs remain salient across the various breakdown possibilities.

A typical profile is shown in Figure 4. The bars represent running averages from the various individual ratings in a particular area or function. hey are in arbitrary units. The main point for interpretation is that the longer the bar, the greater is its cause for concern.

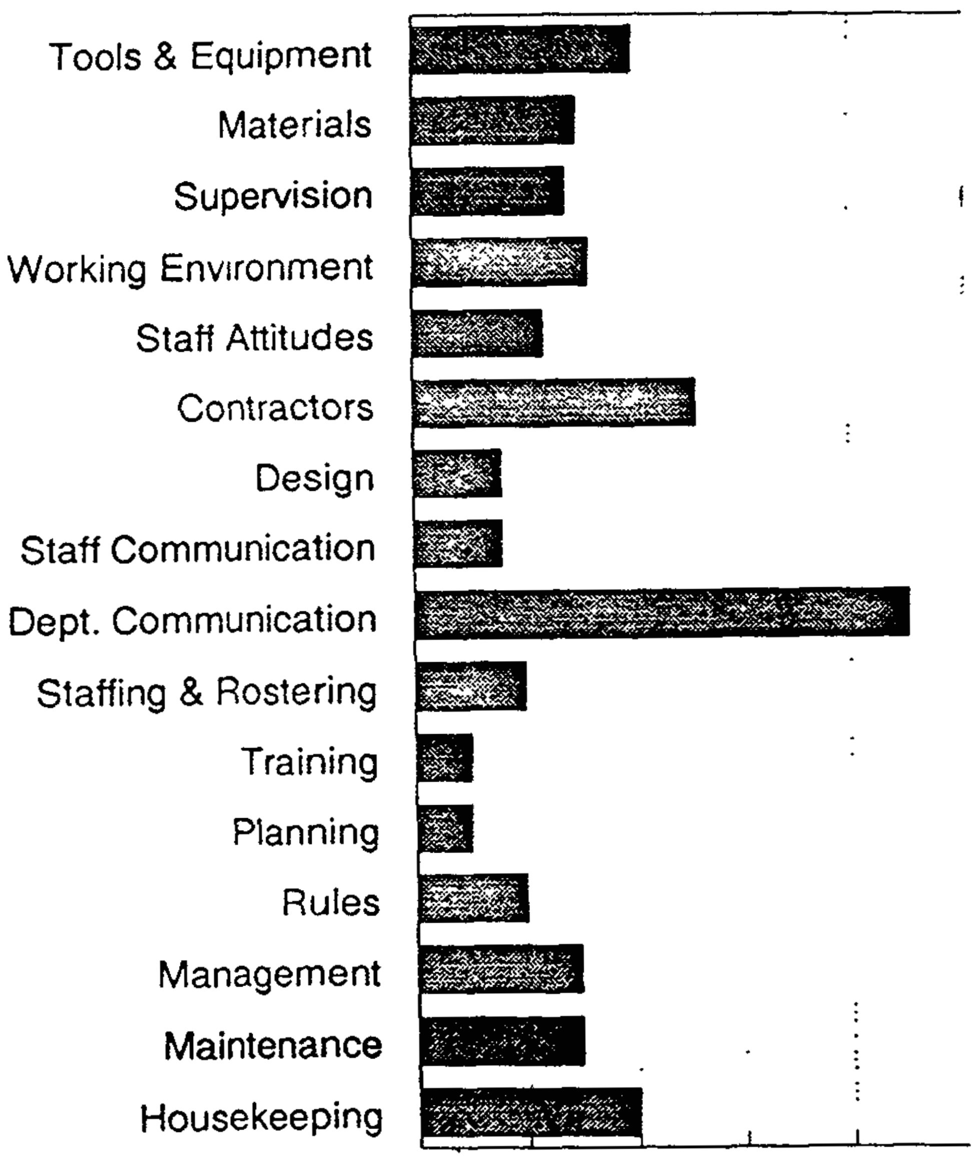


Figure 4 Showing a hypothetical Railway Problem Factor Profile

VARIETIES OF PROFILES

For the purposes of interpretation, it is useful to think of the REVIEW program producing different kinds of summary indicators:

- Local function indicators: these are profiles relating to the work within a particular function (e.g., signalling) within a particular area (e.g., Doncaster).

- Area indicators: these are profiles which aggregate the data across all functions within a particular area.

- Function indicators: these are profiles which aggregate the data from a given function across all areas

- Business unit indicators: these are profiles which aggregate across both functions and areas for a particular business unit (i.e., East Coast Main Line). These give a very coarse-grained indication of the "culture" of the unit as a whole.

Profiles of any of the above kinds can be obtained at any time from the REVIEW program through a menu selection facility. These will only be meaningful provided the program has been "running" for a sufficient period to allow multiple inputs. REVIEW gives relative rather than absolute values. Thus, we are interested in the relative differences between RPFs and their changes over times.

REVIEW AND TOTAL QUALITY MANAGEMENT

REVIEW extends current safety management methods in two ways. First, it takes account of what has been learned over the past 20 or more years regarding the types and origins of human errors. Second, it does not restrict the management of safety to what occurs on the track, in the cab or in the shunting yard, but encompasses fallibility at all levels of the system.

REVIEW and TQM have the same goals, but they employ different methods. REVIEW augments and enhances the scope of quality management by exploiting current human factors research findings. In short, it adds professional human factors to professional quality management.

COMPARING REVIEW WITH EXISTING METHODS OF SAFETY MANAGEMENT

Existing safety management techniques have evolved over more than 160 years of railway operations. They have been driven in large part by the desire to prevent the recurrence of the last incident or accident. Though of proven value, these current forms of safety management have a number of limitations, particularly narrowness of focus. Some of these problems are listed below:

- They focus more upon active (sharp end) unsafe acts than upon latent system failures.

- They focus more upon the personal rather than upon the situational or systemic contribution to accidents.

- They tend to "firefight" the last accident rather than anticipating and preventing the next one.

- They rely heavily on exhortations and disciplinary sanctions.

- They still employ blame-laden terms like "carelessness", "bad attitude", "irresponsibility" (even in TQM).

- They are generally not informed by current human factors knowledge regarding error and accident causation.

In brief, they tend to be piecemeal rather than planned, reactive rather than proactive, fashion-driven rather than theory-driven. They also ignore the substantial developments that have occurred in the behavioural sciences over the past 20 years in understanding the nature, varieties and causes of human error.

SUMMARISING THE REVIEW PRINCIPLES

- Accidents in well-defended and complex railway systems arise mainly from the insidious accumulation of latent organisational and situational failures.

- On rare occasions, these latent failures can combine with local triggering factors (weather, signal locations, etc.) and active failures (errors and violations) to breach or bypass the defences.

- Human rather than technical failures now represent the greatest threat to the safety of railways.

- Human failures can be moderated but never entirely eliminated. The same is also true for the hazards intrinsic to railway operations. Thus, there can be no such thing as absolute safety.

- Different types of unsafe act have different underlying mechanisms, occur in different parts of the organisation and require different methods of management.

- Safety significant errors occur at all levels of the system, not just at the sharp end.

- Measures that involve sanctions and repeated exhortations (i.e.,"be more careful") have only limited effectiveness. Systems, situations and tasks are more manageable than people.

- Unsafe acts are the product of a chain of causes in which the individual psychological factors (i.e., momentary inattention, forgetting, etc.) are the last and often least manageable link.

- Negative outcome data (accidents, incidents, lost time injuries, near misses, etc.) are an essential part of any safety information system, but by themselves they are too little and too late to support effective safety management.

- Accidents, by their nature, cannot be managed directly. Too many of their causes lie outside the control of the system managers.

- The only realistic goal in safety management is to achieve the greatest degree of intrinsic resistance to ever-present accident-causing factors and then to sustain it.

- Safety management should not be a reversed production process aimed at bringing accidents, lost time injuries, etc., down to some reduced target value. Safety management must be a long term fitness programme based upon regular measurements of "safety health".

A summary of the Benefits are given in Appendix 2.

D K Wharton-Street
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APPENDIX 1

ORGANISATIONAL FACTORS

Extensive observations, covering a range of grades, departments and areas, have identified 16 organisational factors that can have an adverse effect upon railway work. These have been termed Railway Problem Factors (RPFs) and are listed below. Beneath each heading are example items (not a comprehensive listing) relating to each RPF.

TRAINING	Adequacy and quality of training, use of training aids (simulators, videos etc.), refresher courses and information updates, regularity (too much/not enough).
TOOLS AND EQUIPMENT	Availability of proper tools and equipment, suitable ordering procedures for spares and replacements.
MATERIALS	Consumables readily available in sufficient quantity, suitable ordering procedures.
DESIGN	Workplace and equipment design, suitable for work, easy to use, ease of transportation and handling, standardisation of equipment.
STAFF COMMUNICATION	Sources of information, notices, working instructions, safety meetings, team briefings, communication between management and staff.
RULES	Rule book, local rules and regulations, language, ease of comprehension, not enough, too many, unmanageable, inadequate.
SUPERVISION	Attitude of immediate supervisors/managers, interference, insufficient contact/communication.
WORKING ENVIRONMENT	Working conditions, weather, eating/drinking/resting facilities.
STAFFING & ROSTERING	Staff availability/numbers, hours worked, shift arrangements, weekend working.

STAFF ATTITUDES	Job insecurity, negative attitudes, poor relationships, absenteeism.
HOUSEKEEPING	Vandalism, tidiness, debris from previous work, cleaning.
PLANNING	Weekend work, contact with all those involved, site visits, meetings.
DEPARTMENTAL COMMUNICATION	Contact/relationship with other departments, co-operation.
MANAGEMENT	Remoteness, attitude, interference, incompatible goals, impossible demands.
CONTRACTORS	Attitude, working practices, safety procedures, railway knowledge.
MAINTENANCE	Reporting procedures, time scale, delays, quality.

It will be noted that six of these RPFs (tools/equipment, materials, supervision, working environment, staff attitudes and housekeeping) deal primarily with workplace conditions. The remainder relate to generic organisational processes.

APPENDIX 2

"REVIEW"

BENEFITS

-

- Pro-active not re-active.
- Identification of "process" and "latent" risks.
- Involvement of safety critical staff.
- Increases safety awareness.
- Bottom-up not top-down initiatives.
- Forms a basis for 'loss' control.
- Aids insurance assessment.
- Improves safety culture throughout the Profit Centre.
- Little additional time.
- Low or no cost.
- Simple to operate.

DISBENEFITS

No disbenefits have, as yet, been identified.

However Review requires:

- Management conviction, from the top, to make the system work effectively.
- Risk to management in the way the organisation reacts to staff perceptions and recommendations.

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DWS060893/jat

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HUMAN FACTORS RESEARCH (REVIEW)

Because of time constraints, the paper given today does not include a detailed explanation of the systems and computer programme in support of REVIEW.

If you are interested in developing REVIEW within your Organisation and require more detailed explanation, will you kindly make contact with the Safety Policy Unit at the address printed above.

David Wharton-Street
Human Factors Adviser
Safety Policy Unit

DWS221093/1/jat

Development of a pro-active system for measuring organisational safety health in a railway environment.

A paper for:

THE INTERNATIONAL RAILWAY SAFETY SEMINAR.

ANGERS (FRANCE)

S.Tozer
D.Wharton-Street

October 1993

ABSTRACT

The paper will be presented by Sarah Tozer, Ergonomist in the Human Factors Research Department and David Wharton-Street, Human Factors Adviser in British Rail's Safety Policy Unit.

The paper is based on research sponsored by British Rail with Professor Reason in the Department of Psychology - University of Manchester.

The concept in the paper addresses organisational safety health in a Railway environment by identifying potential active and latent failures prior to a damaging event. This is achieved by the use of a pro-active measuring system involving safety critical staff, supervisors and managers.

The measuring system encompasses organisational pathogens and core processes expressed as sixteen Railway Problem Factors.

The aim of this second paper in support of the presentation is to explain the requirement for a change in the Safety Management culture of British Rail, and how the development of "REVIEW" was undertaken in order to address apparent shortfalls in this culture.

1. WHY THERE IS A NEED TO INVESTIGATE LATENT FAILURE

Railway accidents and near misses have tended to focus upon the active failures of the staff at the 'sharp end'. Particular emphasis has been given to the violation of rules and the Human error of Railway men such as Drivers, Shunters, trackside workers and others in direct contact with hazards.

The remedy has always been to take steps to prevent a recurrence. The remedy is usually in the form of :

* Engineered safety measures
* Amendments to the Rule Book.

But, the evidence of major catastrophes of the 1980's clearly indicates that the staff at the 'sharp end' are the inheritors of latent failures - not the instigators of accidents.

The challenge is to be able to identify and eliminate these latent failures in the organisation.

But, how can we identify these failures? How can we open up the organisation so that the situational factors that lead to unsafe acts and accidents are made visible?

Only by creating this 'visibility' can we:

* eliminate the failures at source
* improve the safety culture.

Whatever system is developed it must not be a substitute for current railway safety management systems. It needs to be an enhancement to the safety systems already existing in the organisation.

British Rail's current safety management practice normally involves a structure of frequent safety briefings down through the organisation to all staff who operate at ground level.

However, we have identified some core problems with the safety management system.

* Current limited amount of feedback on safety matters from ground level staff.

* Different perceptions of safety at each level of the organisation.

* A general failure of management to recognise latent problems until accidents happen.

* A reactive assessment of accidents.

Preferably any new system should address these four shortcomings.

2. A NEW WAY FORWARD

The Piper Alpha oil-rig explosion and the detailed causational analysis and resultant recommendations by Lord Justice Cullen was the clue to unlocking latent failure identification.

The detailed review of causes carried out by Professor Reason and other specialists, indicated that the clue to latent failure identification lay within the working practices and inherent concerns of the staff.

Professor Reason's recommendation to British Rail was to investigate the problems as perceived by our staff. He assured us that this would lead to the required visibility of latent failures in the organisation.

It is recognised that the perceptions of staff towards safety are synonymous with organisational problems.

3. IDENTIFICATION OF THE RAILWAY PROBLEM FACTORS

To achieve this a structured methodology for the collection of the required information was undertaken. In order to gain a full picture of staff attitudes to safety, staff of all grades (ground based, supervisors and management), from a broad range of geographical locations and across all safety critical areas of work were selected for study. The research was based on a program of subjective data gathering techniques which became increasingly structured as the work progressed. This was followed by a process of validation.

i) <u>Participative research</u> -

Initially a Human Factors Team member joined a track maintenance gang to gain a first hand insight into the staff's perceptions of their work. As an overt observer a broad overview of attitudes to their work, their feelings about the railway and other motivational factors were identified.

ii) <u>Interviews</u> -

In order to establish the validity of the factors identified from participative research, a wider cross section of staff of various grades (ground based, supervisors and management) and location in one safety critical area (track maintenance) was selected for interview. The interviews provided a forum to generate further safety related factors. A selection of the factors identified by supervisors on the East Coast Main Line can be seen in Appendix A.

iii) Working group -

A working group was set up which comprised Human Factors specialists, Professor James Reason and staff from various railway businesses, in order to identify the salient factors from those generated to date. Through a process of grouping and weighting a core of 16 distinct Railway Problem Factors (RPF's) was generated.

Training
Tools and equipment
Materials
Design
Staff communication
Rules
Supervision
Working environment
Staffing and rostering
Staff attitudes
Housekeeping
Planning
Departmental communication
Management
Contractors
Maintenance

iv) Validation -

As the factors had been developed by one group of Safety Critical Staff it was necessary to test them on other safety critical staff groups, ie Signalmen, Drivers, Shunters, Fleet Maintenance and Equipment Maintenance Staff.

Further interviews provided verification that all staff groups recognised the 16 factors as a valid and comprehensive set for their work type.

4. MEASURING TECHNIQUE

Having now identified the 16 RPF's a technique to measure the strength of feeling towards these needed to be developed. A questionnaire was designed evaluated and modified by a series of trials with the target users.

i) Development -

The three issues that were considered important to clarify were:

* Question wording
* The rating system
* Prompts (factor description)

The trials allowed the language of the questionnaire to be matched to the understanding of the users and to establish the optimal rating scale for eliciting opinion. A further requirement was that a list of prompts of each of the 16 factors were suitable for each safety critical group of staff.

ii) <u>Evaluation</u> -

For the technique to be effective four criteria had to be satisfied. The trailing process allowed the following four issues to be evaluated.

* Ease of use by staff
* Accurate data collection
* Effective analysis
* Minimal resource requirement

iii) <u>Modification</u> -

The evaluation process highlighted the fact that although in general the questionnaire provided an easy method of obtaining accurate data, the prompts provided were inadequate for all user groups. The prompts needed to be tailored so that the description of the factor was meaningful for each safety critical group of staff. Similarly discrepancies in interpreting the numeric rating system were noted. The evaluation process also highlighted the method of data analysis was too complex. The trailed method involved paper based scoring of the questionnaires which then needed to be coded and transferred to a statistical computer package. This process was found to have a number of faults.

* Time intensive
* Error prone - due to inaccuracies during transfer
* Inappropriate statistical computer package - the generation of graphs and data into a meaningful format was complex with currently available packages.

5. **SYSTEM DESIGN** (THE REVIEW PACKAGE)

A simple computer based system was developed as a tool which could be taken forward for verification. This method was chosen because it had a number of benefits. This included the ability to retain the positive attributes already established in the paper based system, namely meaningful question wording which aided accurate scoring of attitude.The computer had no disadvantages in its ability to present the questions and prompts. Further benefits included the fact that time was saved because firstly the data no longer required coding nor transfer to the analytical tool. As a consequence errors resulting from transfer would be eliminated and data input directly into a dedicated tool for analysis geared to produce output in a meaningful format.

Advantages

The package also builds on the positive attributes of the paper based system because the input process is scored using an increasing bar size to represent strength of opinion which is reinforced using verbal descriptors. The output is customized to provide a graphical image (or profile) of the RPF's which can be broken down according to grade, location and business function. This enables the user to compare and contrast data gathered for various staff groups, hence giving a picture of the different perceptions of safety within the organisation.

The computer package also provides flexibility in terms of the prompts that can be made available to the user, depending on individual status (grade location and function). The computer based system met the minimum requirements of the four criteria set out and also provided additional benefits thereby providing an effective measuring technique.

6. THE PILOT SCHEME

i) Interface with the safety management system

Safety management should not be a reversed production process aimed at bringing accidents, lost time injuries etc down to some reduced target level. Safety management must be a long term fitness level based upon regular measurements of 'safety health'.

To reduce costs and time, within British Rail it was agreed that the use of the new computer system called REVIEW would be related to the frequent safety briefing system. Within a line management organisation, the briefing system extends from the director to each member of staff.

Using the briefing system REVIEW can provide selected safety indicators (profiles) broken down in a variety of ways:

* by grade of assessor (eg supervisor of managerial)
* by functions and activities (eg signalling, shunting)
* by Railway areas (eg Doncaster, Edinburgh etc)
* by Business unit (eg East Coast Main Line)
* by Business (eg Intercity)

ii) Aims of pilot scheme

* To ensure that the system is flexible hence able to fit the specific requirements of the various businesses and functions within British Rail.

* To test the robustness of the system in terms of collection, handling and analysis of data.

a) Timescale:- The pilot would run for a 6 month period to allow time to set up the system, a number of data collection periods and time for analysis of the results.

b) Objective:- The objective in terms of target audience for the pilot, was to firstly cover a cross section of Railway Businesses and secondly to ensure that at least one example of all groups of safety critical staff were covered.

The criteria by which verification would be judged was similar to those highlighted earlier, namely:

* Data collection
* Data analysis
* Data interpretation and evaluation
* User friendliness
* Robustness of the system
* Flexibility of the system in terms of fitting the various businesses and functions within British Rail
* Cover a sample of all safety critical staff

iii) Structure of pilot scheme

To verify the above criteria computer based measuring technique (REVIEW) was installed in three of British Rails five main businesses.

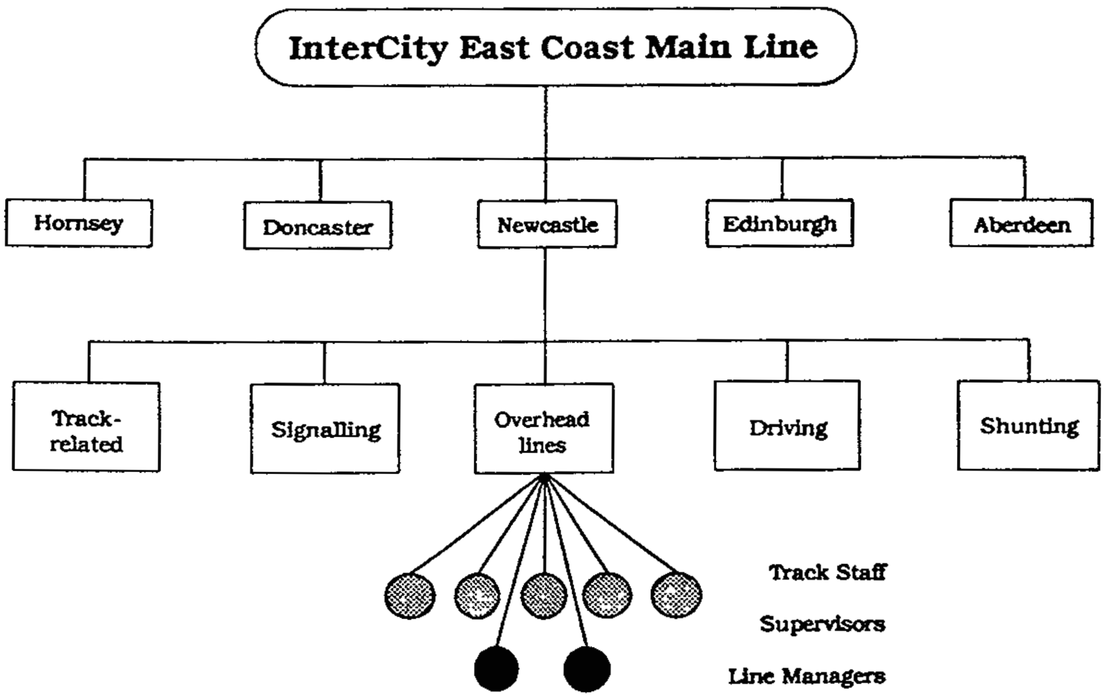
BUSINESS	Regional Railways	Intercity	Trainload Freight
PROFIT CENTRE	South Wales & West	East Coast Main Line	Yorkshire Freight
FUNCTION	Fleet Infrastructure	Fleet Infrastructure Operations	Operation

From the three line management Business Profit Centres samples from safety critical staff in the following functions were included in the scheme.

Function	Staff Group
Fleet Maintenance	Maintenance Staff and Cleaners
Operations	Signalmen, Drivers, Shunters/Train Preparers
Infrastructure	Track Maintenance, Signal Maintenance, Overhead Line Maintenance, Equipment Maintenance.

It is to be noted that the pilot scheme covers the same staff group type at a number of locations. In due course, this will aid comparison of results between staff within the same activity.

A more detailed example of the organisational structure of a Profit Centre is shown on the chart for the East Coast Main Line.



iv) REVIEW implementation

a) Decisions

The British Rail Businesses were approached and offered the opportunity to implement REVIEW on a 6 month trial basis. The policy decisions about how implementation would be structured within each individual Business were made by each Businesses own management. Such decisions included who was to control the project, which staff would contribute and how often contributions would be made.

b) Training

The method of training business staff was two tiered. Firstly the REVIEW Project Manager imported information regarding the REVIEW system in general and how to set up, operate and maintain the system to the management group who would control REVIEW in that business. The second tier fed down from this group to all staff involved in use of REVIEW.

c) Data input

As part of REVIEW implementation there were three distinct structures established for the gathering of data on a computer based system.

* Computer Suite - where available a computer suite comprising a number of IBM compatible standalone PCs was used as central point for data input. Where the computer suite was used it formed part of the established safety briefing programme.

* Single point - where only one PC was available staff were required to travel to the computer to make inputs.

* Portable computer - where the normal work location made it difficult to travel to a single point a lap top (portable) computer was taken on site.

d) Frequency of input

In order for REVIEW to be valid, input is required routinely. The frequency of input was also to some extent a Business Management decision based on the frequency of safety briefings, the method of data input their own preferences. However, the rationale behind REVIEW requires a minimum frequency of individual making inputs at least once every 8 weeks.

The frequencies being tested in the pilot scheme are once every 2, 4, 8 weeks. A further requirement is that at least 30% of the safety critical staff of each staff group type at any one location being looked at must input data routinely to be statistically significant.

e) Feedback Techniques

Perhaps the most critical feature of the system is its ability to provide meaningful feedback relating to the inputs that are made.

i) How is feedback given

Feedback is provided in a graphical format where the strength of feeling towards each of the 16 RPFs is seen for any combination of requested variables (grade, function, location, business and profit centre). Any RPF to which a significantly higher strength of feeling is attached manifests itself graphically as a peak above the base line opinion.

ii) When is feedback given

Feedback is made available in three work contexts depending on the method and frequency of data input. Where a computer suite is used in conjunction with a safety briefing session feedback may be made available during this session or the following one. In those instances where input is made at a single point, feedback is made available at the next safety briefing that staff attend. Where data input is carried out on site, using a portable computer, the feedback is available immediately or at the next input session.

iii) Feedback discussion

Once feedback has been produced, discussion is initiated. Depending on the input method the forum for discussion may either form part of the safety briefing or not.

7. EMERGING RESULTS

The pilot scheme has only run for 2 of the allocated 6 months for the trial period. The results emerging are therefore provisional but do suggest that REVIEW will be conclusively shown to be effective in meeting its aims and objectives.

The results to date with respect to the criteria stated earlier, against which verification would be judged, are as follows:

i) Data collection

Each of the three methods for collecting data have enabled the users to input required data at the frequency defined by respective Business Management team. It is reasonable to assume that effective data entry is indicative of appropriate question wording and prompting. This has been supported by subsequent interviews and conversations.

ii) Data analysis

The computer program, dedicated to analyze the collected data has provided the results in a format readily understood by the users.

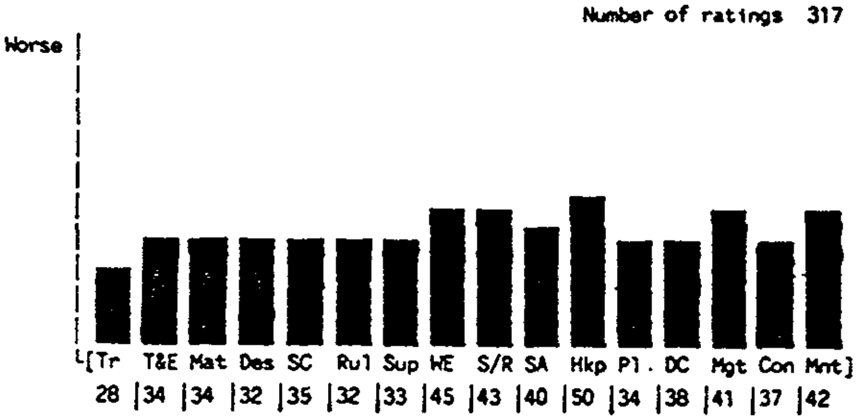
iii) Data interpretation and evaluation

As stated the results to date are only provisional but indications are that the facility to breakdown the data into specific profiles enables any peaks to be identified as emergent features. An example of the process by which data is broken down into selected profiles can be seen in Appendix B. The figure below illustrates clearly how peaks can be identified.

BR REVIEW Data Analysis

Analyse data in file:	REVIEW.DAT
Between dates:	00/00/00 and 20/08/93 (inclusive)
Grade:	<don't care>
Function:	Freight
Location:	<don't care>
Area/Profit Centre:	Yorkshire
Business:	Trainload Freight

Number of ratings 317



iv) User friendliness

One element about which positive conclusions can be drawn is the acceptability and usability of the REVIEW system. Staff of all grades found the system easy to use, understandable and manageable. To some extent the 'fun element' of using a computer based tool added to the already established safety management structure.

v) Robustness of the system

Although evidence to date suggests that the REVIEW system is capable of handling the required levels of data input and is reliable it is too early to draw conclusions regarding firm proof of this.

vi) Flexibility of the system

The system has fitted into various businesses and functions within British Rail. This has required only limited adaptions to be made with respect to customized prompts. The lack of changes needed for the system to be implemented by any business illustrates clearly the flexibility of the system.

8. SUMMARY

All early indications from experience in setting up the system for trial, managing the pilot scheme and discussing the feedback, suggests that the final conclusions will conclusively prove REVIEW to be an effective and flexible safety management tool.

APPENDIX A

Sample of problem factors raised by supervisors on the East Coast Main Line

1. Planning meetings not always attended by all relevant staff.
2. Irregularities within track possessions
3. Tamper work in a possession without marker boards
4. Too many forms to fill in before track work
5. COSHH regulations
6. Working in a strange area
7. Bidirectional working
8. Working with p/way staff (s & t complaint!!)
9. Difficult access to site
10. New staff in the area
11. Working in darkness
12. Fibre repairs
13. Vandalism
14. Dust problems (coal, ballast etc.)
15. Old working practices die hard!!
16. Working without lookouts
17. Safety paperwork
18. Duplication of effort
19. Delivery problems with new equipment
20. Manpower fluctuations
21. Inadequate training
22. Servicing/inspection of hire vehicles
23. Different rules in different departments
24. Problems with ballast cleaning
25. Problems with contractors
26. Pee wee cable problems
27. Back injuries from lifting
28. Introduction of non flame retardant vests
29. Misting of goggles
30. Appreciation of ac lines
31. Staff morale
32. Positioning ladders against tower scaffolding
33. Fumes in tunnels

APPENDIX B

Figure 1 represents an overall mean rating for all staff from one Business over a single cycle of inputs. It is difficult to readily distinguish significant peaks from baseline opinion because of the averaging effect resulting from individual differences based on location and grade.

BR REVIEW Data Analysis

Analyse data in file: REVIEW.DAT
Between dates: 00/00/00 and 20/08/93 (inclusive)
Grade: <don't care>
Function: Freight
Location: <don't care>
Area/Profit Centre: Yorkshire
Business: Trainload Freight

Number of ratings 317

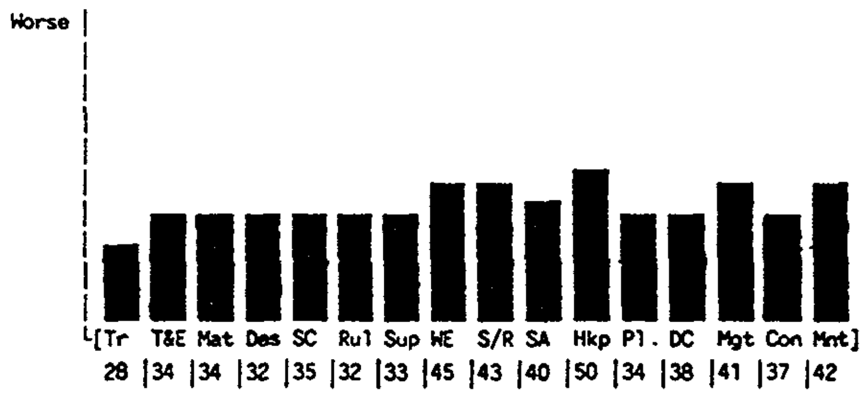
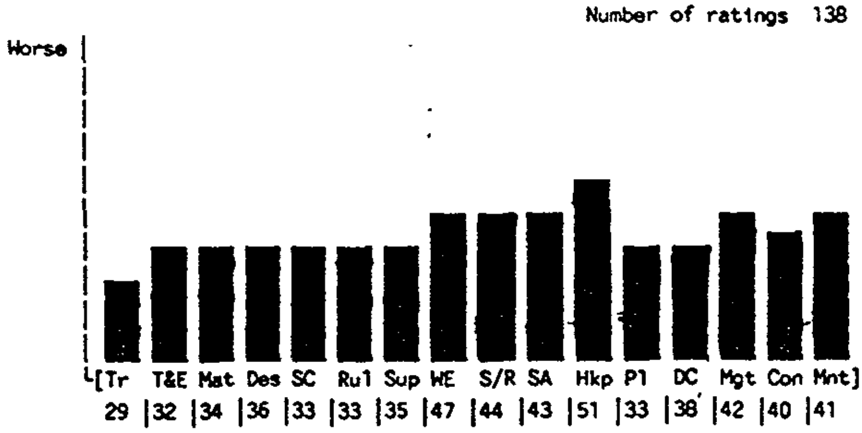


Figure 2 shows how the next step in the process of breaking down data by choosing selective profiles, in this case grade defined as Driver begins to reveal areas of strong opinion, however it is still not possible to identify the pertinent Railway Problem Factors.

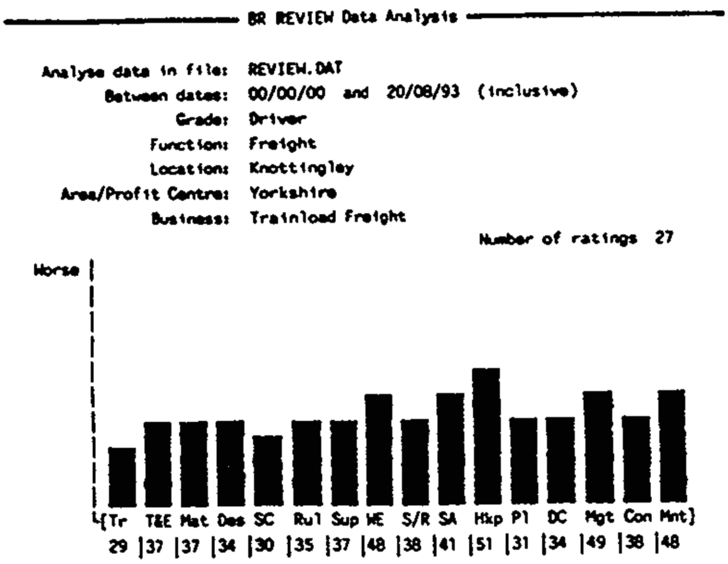
BR REVIEW Data Analysis

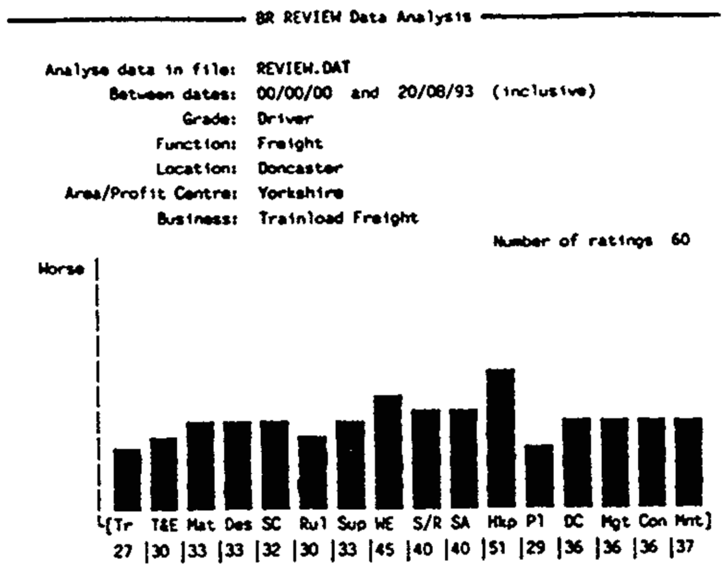
Analyse data in file: REVIEW.DAT
Between dates: 00/00/00 and 20/08/93 (inclusive)
Grade: Driver
Function: Freight
Location: <don't care>
Area/Profit Centre: Yorkshire
Business: Trainload Freight

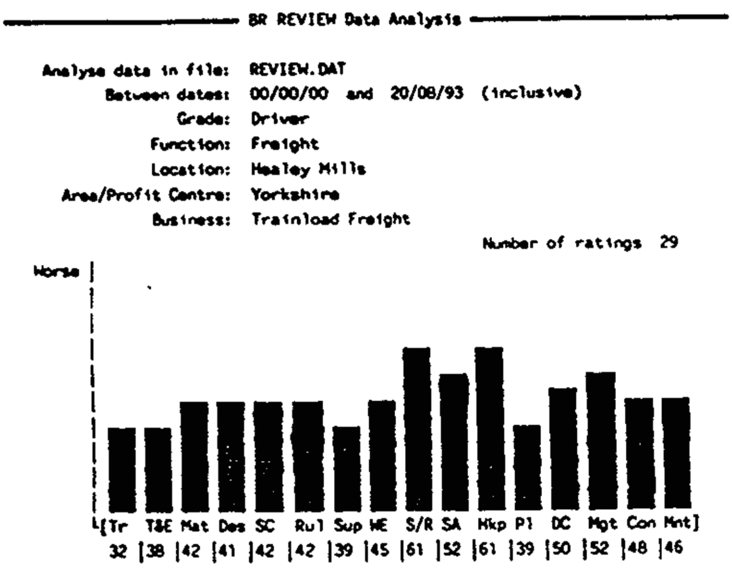
Number of ratings 138

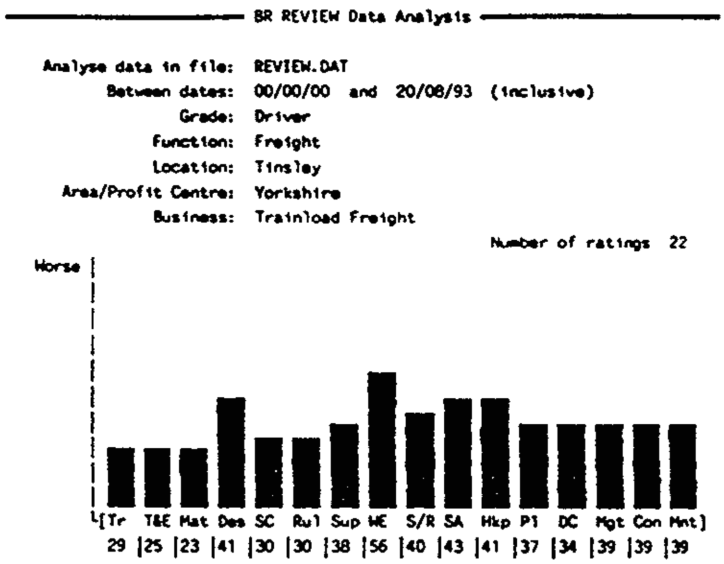


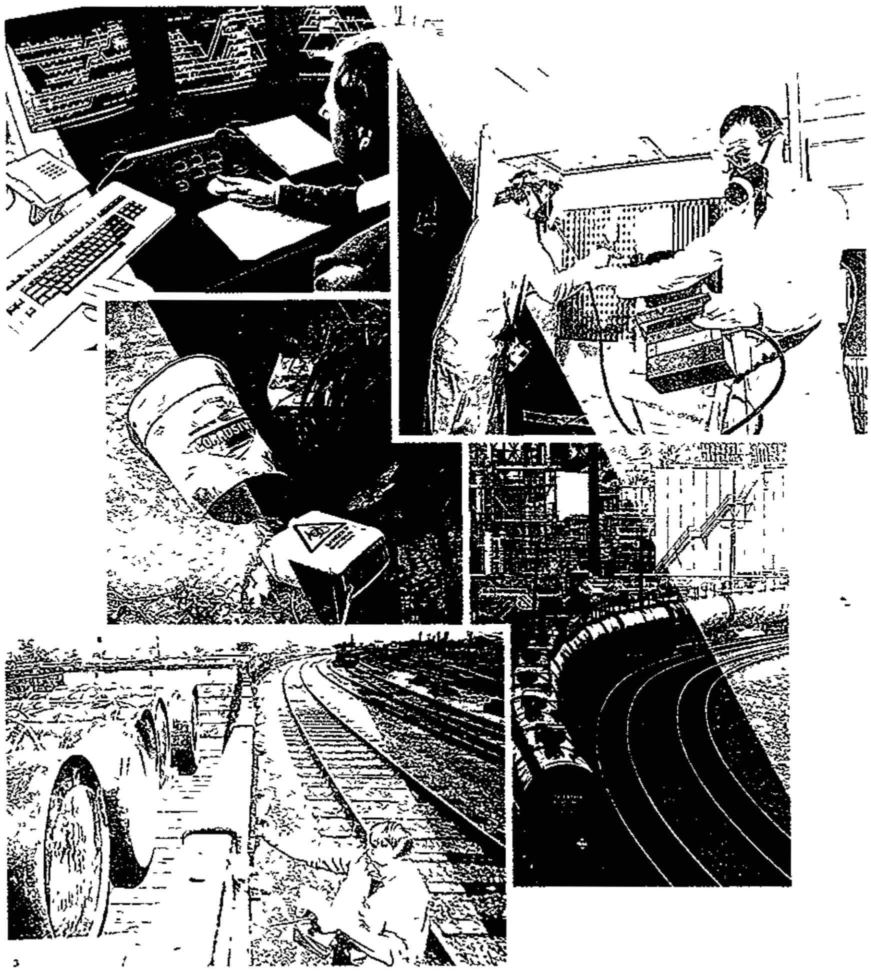
Figures 3a-d mark a further step in the analytical process because location has been used as another filter in deriving a profile that clearly illustrates any peaks present in the data.











Analysis, Consultancy and Advice on

Health & Safety

British Rail Research

health & safety

Health and Safety embraces every facet of our lives whether we are at work or at play. The breadth and diversity of the subject can lead to difficulties in sourcing the information or solutions you seek. At British Rail Research our professionally qualified scientists and technicians have been providing Britain's railways with the answers they need for over 20 years. We are now able to offer our skills, knowledge and experience to you.

Some of the services available include:

- Occupational Hygiene Consultancy
- Environmental Management
- Human Factors Consultancy
- Traffic and Dangerous Goods Advice
- Radiological Protection Advice
- Fire Technology
- Derailment Investigation

Work is undertaken to comply with all U.K. Regulations and European and International requirements where applicable. Regulations present ever more complex safety problems to the manager. With our help you can successfully comply with Regulations and provide a quality workplace for your staff, which could lead to future financial benefits.

Regulations present ever more complex safety problems to the manager

Occupational Hygiene Consultancy

Advice covers such areas as; COSHH, Noise, working with Asbestos and Lead, Confined Spaces, use of Personal Protective Equipment, Legionella monitoring amd interpretation of Legislation.

We provide full on-site assistance covering workplace monitoring to make constructive recommendations for reducing personnel exposure, and meeting legal responsibilities. Staff training can be provided to meet your specific needs and to comply with legislative requirements for employee instruction and training.

Environmental Management

Management's environmental responsibilities are increasing rapidly, and we offer guidance on legislative compliance and practical advice on environmental emissions, waste reduction, contaminated land issues etc. We carry out full on-site studies to provide achievable results in all aspects of environmental management.

Human Factors Consultancy

Investigations into all aspects of the man/machine interface are undertaken. We take account of psychological and ergonomic aspects of human behaviour and make recommendations based on a clear understanding of human strengths and weaknesses.

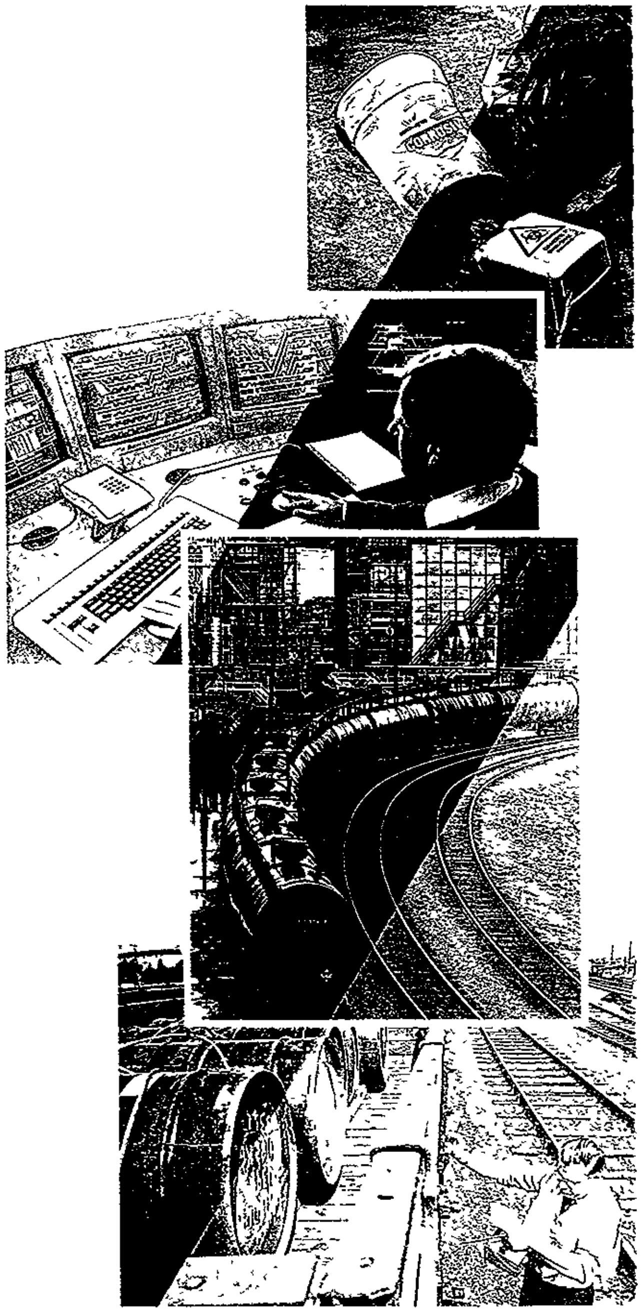
Individual studies into Work Related Upper Limb Disorders and assessment of VDU workstations are two examples of this specialist field.

Traffic and Dangerous Goods Advice

Advice is available on the legal and practical aspects of acceptance, handling and transportation of all forms of dangerous materials by any means of surface transport anywhere in the world. The group is actively involved in drafting national and international regulations, so our advice is always current, relevant and appropriate.

Radiological Protection Advice

Our Radiological Protection Adviser is available to help ensure that you meet your statutory responsibilities. Additionally, our radiological protection supervisors are trained to advise on any precautionary measures which are required and to ensure your full compliance with national legislation.



Enviromental responsibilities are increasing rapidly

*F*ire Technology

Supported by modern sophisticated technology, a wide range of skills are available to enable advice to be given on material properties, regulations and design criteria. The range of services we provide includes fire testing to recognised standards, investigations, consultancy and ad hoc testing tailored to your specification.

Our extensive, nationwide laboratory network enables a rapid response to all enquiries and requests for assistance. We use the most sophisticated monitoring equipment and technology available.

Supported by modern sophisticated technology

*F*or more information contact:

The Business Development Manager
British Rail Research
P.O. Box 2
London Road
Derby DE24 8YB

Telephone: Derby (0332) 264908
Fax: Derby (0332) 264913

International Telephone: +44 332 264908
International Fax: +44 332 264913

or contact the laboratory nearest to you:

Derby : Tel: 0332 264618
Doncaster : Tel: 0302 362402
Glasgow : Tel: 041 335 2640

Swindon : Tel: 0793 515049
Crewe : Tel: 0270 532372
London : Tel: 081 444 9891

BT/311/0034

Human Factors

British Rail Research Scientific Services offer a full range of services relating to the human behaviour of both the travelling public and staff. We take account of psychological and ergonomic factors in passenger environments and the workplace. There is a need to understand and interpret human strengths and weaknesses so that these may be considered alongside technical and commercial criteria in the design process, and our specialists can provide you with sound, practical advice in this vital area.

Safety Systems

We have examined passenger safety with regard to emergency evacuation and have collated information on the ease of escape from various types of vehicle. Through questionnaires completed by drivers and practical measurement, we have also evaluated the ergonomic aspects of new safety systems such as Automatic Train Protection.

Investigations have been carried out relating to the safety of track activities. This work contributes greatly towards better safety systems for any area of railway operation and leads to a greater understanding of the attitudes of staff at all levels.

New Legislation

Recent EEC directives on Manual Handling, Display Screen Equipment and The Workplace Environment have placed new requirements on managers. Our qualified and experienced staff will undertake assessments and surveys in connection with this legislation and ensure that you receive the best possible guidance.

Consultancy

We can undertake either short or long term investigations, and provide a consultancy service tailored to your exact requirements relating to any of the following areas:

- Work related upper limb disorders
- Ergonomic aspects of control centres
- Acceptability of new items of equipment
- Workplace ergonomic assessments
- Safety surveys
- Human behaviour in the workplace

Our aim is to provide you with help, advice and detailed recommendations on any Human Factors aspect of your operation.

International
Rail Transport Consultancy
and Research

British Rail Research

For more information, please contact: 0332 263386

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If you feel that our specialists can assist you to solve your current problems, please contact us at either the Derby Headquarters or the nearest outbased laboratory.

The addresses are :

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British Rail Research
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GLASGOW
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CW2 6EA

Tel : 0270 532372
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1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9319

Francois Laporte

The necessity of incorporating the cognitive aspects in accident analysis, An example of a bridgeworker accident

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

THE NECESSITY OF INCORPORATING THE COGNITIVE ASPECTS IN ACCIDENT ANALYSIS : AN EXAMPLE OF A BRIDGEWORKER ACCIDENT

François LAPORTE

Safety Management
Region Laurentienne
Canada National

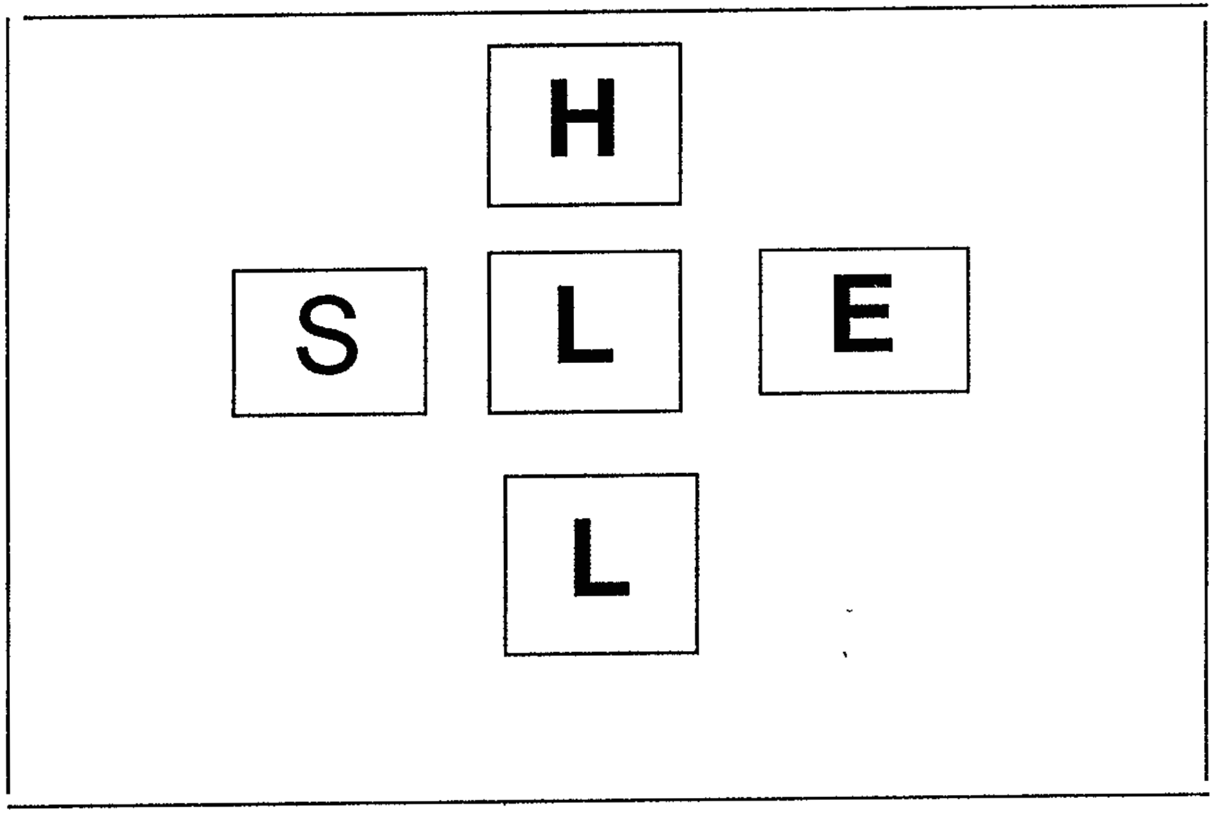
The necessity of incorporating the cognitive aspect in accident investigation

■ *Goal of the presentation*

- *Demonstrate the cognitive aspect of human factors*
- *Define information processing*
- *Explain the influence of the cognitive aspect related to accidents*
- *Review a study case -- Accident happened on a bridge*

The necessity of incorporating the cognitive aspect in accident investigation

- **Shel model** (adapted from Hawkins, 1975)



The necessity of incorporating the cognitive aspect in accident investigation

- ***Liveware-Hardware.***
  - *This interface is the most commonly considered when speaking of human-machine systems*
- ***Liveware-Software.***
  - *This encompasses the interface between humans and the non-physical aspects of the system such as procedures...*
- ***Liveware-Environment.***
  - *The human-environment interface was one of the earliest recognized.*
- ***Liveware-Liveware.***
  - *This is the interface between people.*

The necessity of incorporating the cognitive aspect in accident investigation

- ***Liveware-Hardware interface***
  - *frequent source of error: knobs and levers which are poorly located or improperly coded create mismatches at this interface.*
- ***Liveware-Software interface***
  - *delays and errors may occur while seeking vital information from confusing, misleading or excessively cluttered documentation and charts. Problems can also be related to information presentation, and computer software design .*

The necessity of incorporating the cognitive aspect in accident investigation

- ***Liveware-Environment interface***
  - *caused by environmental factors such as noise, heat, lighting, air quality, vibration ,and by the disturbance of biological rhythms.*
- ***Liveware-Liveware interface***
  - *the focus is on the interaction between people because this process may affect crew and system effectiveness. This interaction also includes leadership and command shortcomings, which may reduce operational efficiency, and cause misunderstanding and errors.*

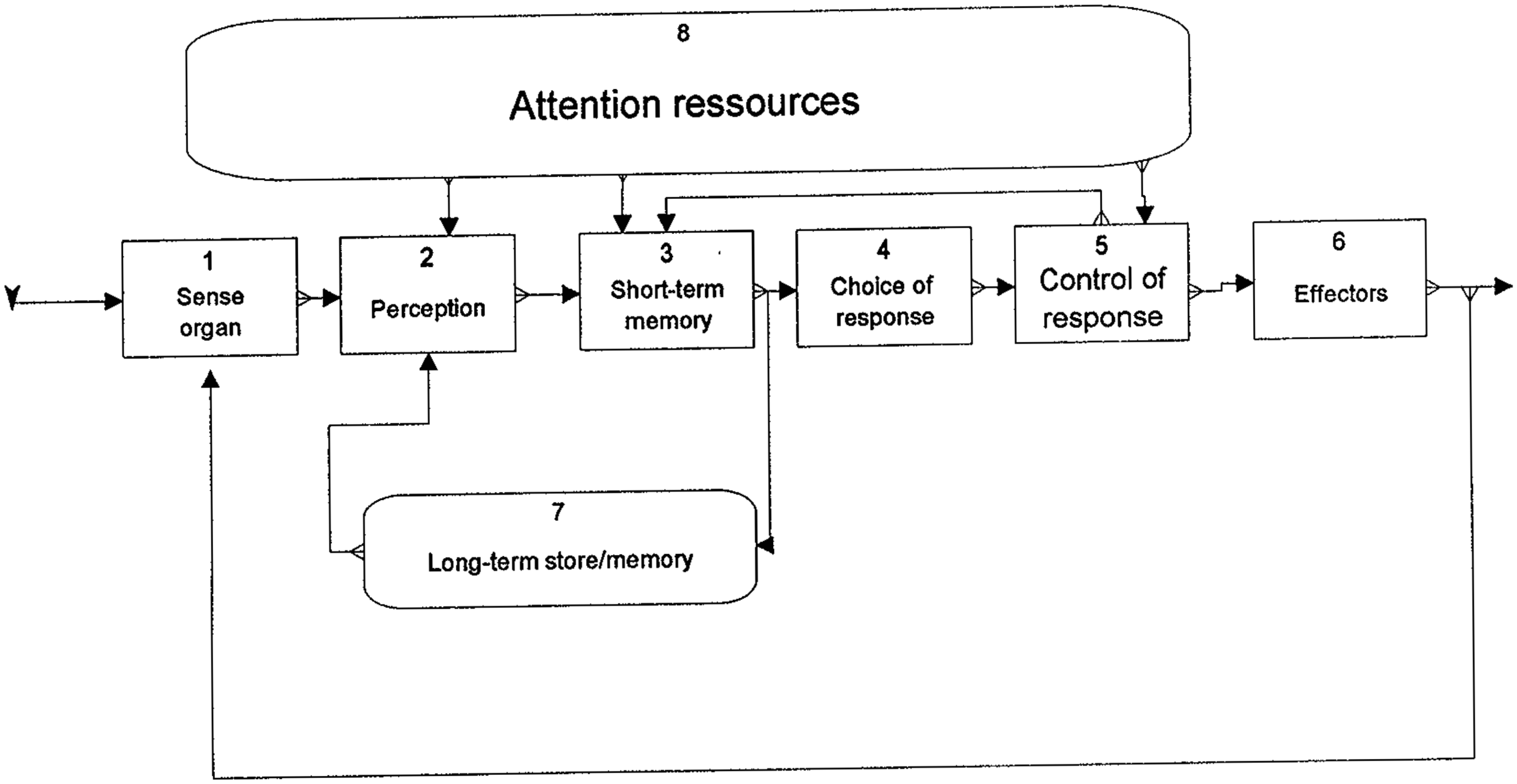
The necessity of incorporating the cognitive aspect in accident investigation

Information processing

- *"In any task to which a human is assigned, information must be processed. Events and objects in the world must be perceived and interpreted, and then either responded to immediately or stored in memory for later information."*

  (Christopher D. Wickens)

- *The information may come from:*
  - *Environment*
  - *Sound*
  - *Visual information*
  - *Everything may have a stimuli on humans*


8
Attention ressources
1
Sense organ
2
Perception
3
Short-term memory
4
Choice of response
5
Control of response
6
Effectors
7
Long-term store/memory

The necessity of incorporating the cognitive aspect in accident investigation

- ***Fatal Accident -- Employee fell From Bridge***
  - *Employees installing walkway on either side of bridge*
  - *Elevation of working surface from ground 21 meters*
  - *Walkway spans do not fit and must be removed (end of the day)*
  - *Positioned on high-rail vehicle equipped with retractable crane*
  - *Track foreman informed of oncoming train*
  - *Employee returning to his truck to clear track*
  - *Three foot opening on left side of truck towards the rear, where walkway span removed*
  - *Employee fell through the hole*

SAFETY AND LOSS CONTROL

DRAFT

FAULT TREE ANALYSIS

30 JULY 1992

CONFIDENTIAL
INTERNAL USE ONLY
AUGUST 19, 1992

INTRODUCTION

1.0 FAULT TREE ANALYSIS

The fault tree analysis is a quantitative or qualitative method of analyzing the ways and means in which an undesired event, including an accident, occurs. Trough logic network diagrams, the relationships and sequences of events which could cause an undesired event are analyzed. For the analysis , each component has to have a specific, constant failure probability. The components are considered to either operate successfully or fail. Partial or degraded operation is not considered. Anything less than full operation is a failure. Once drawn and probability assigned, a complex logic tree can be fed to the computer and failures simulated or the entire life activity of the system.

Beginning with an undesired event (mishap or failure) the fault tree analysis reasons backward, tracking events that could have led us to the unwanted happening. A model (schematic) of the system is used to trace the contributory events. Symbols portray the events in a treelike network developed with increasingly significant and detailed events, In the en completely independent events are reached.

Computers make it possible to process large amounts of information. The computer processes information logically and in a definite sequence. If numerical values of the probability of occurrence can be developed for each of the fault tree basic events, the technique lends itself to computer programming. This is particulary interesting since the key elements of the fault tree, **AND and OR gates**, correspond to logic gates in computer use. This allows the probabilities of an event to be calculated. The analysis requires a knowledge of Boolean algebra and access to a computer.

The calculation will not be used here.

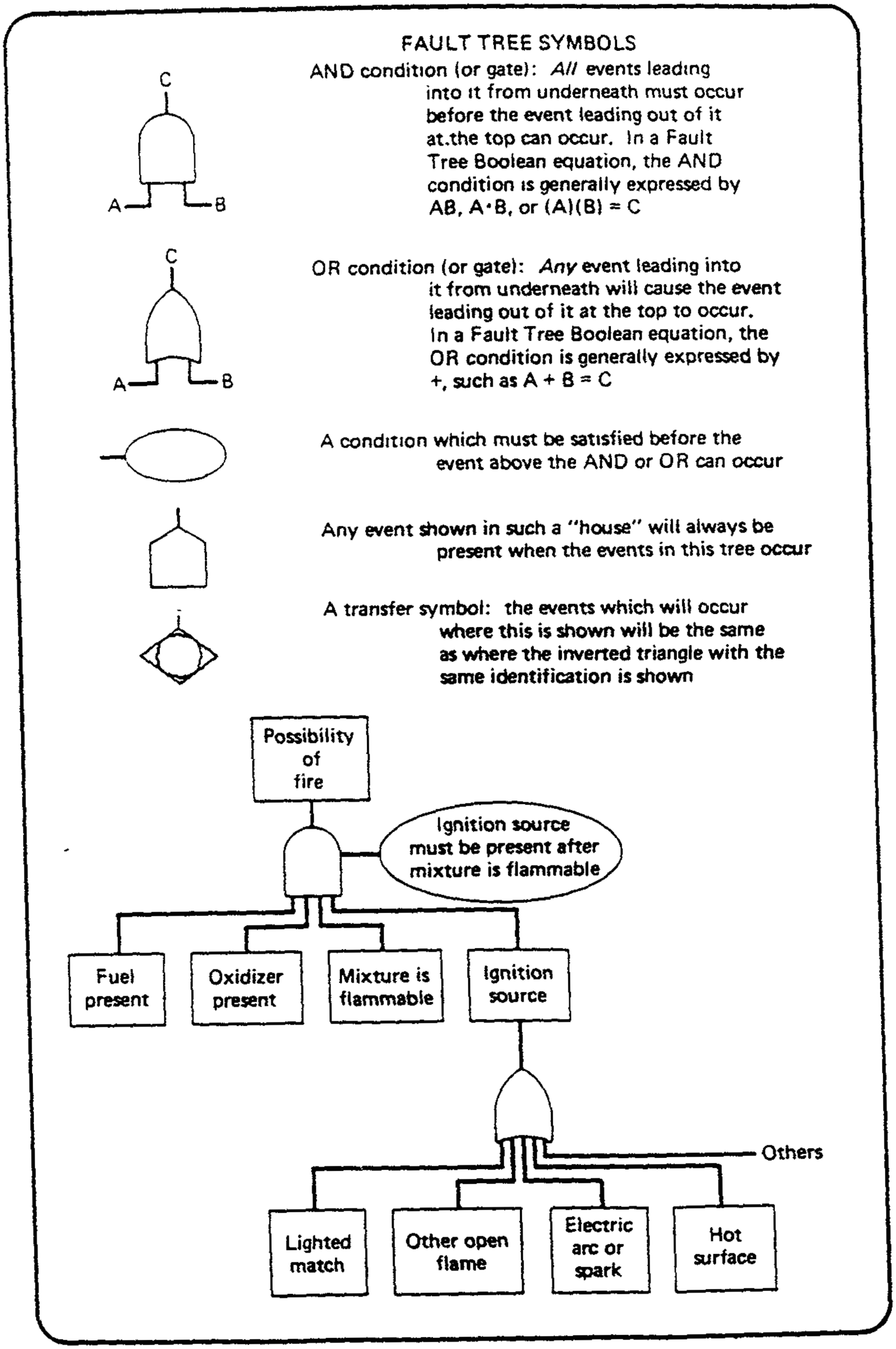


Figure 26-3: Fault Tree Svmbols

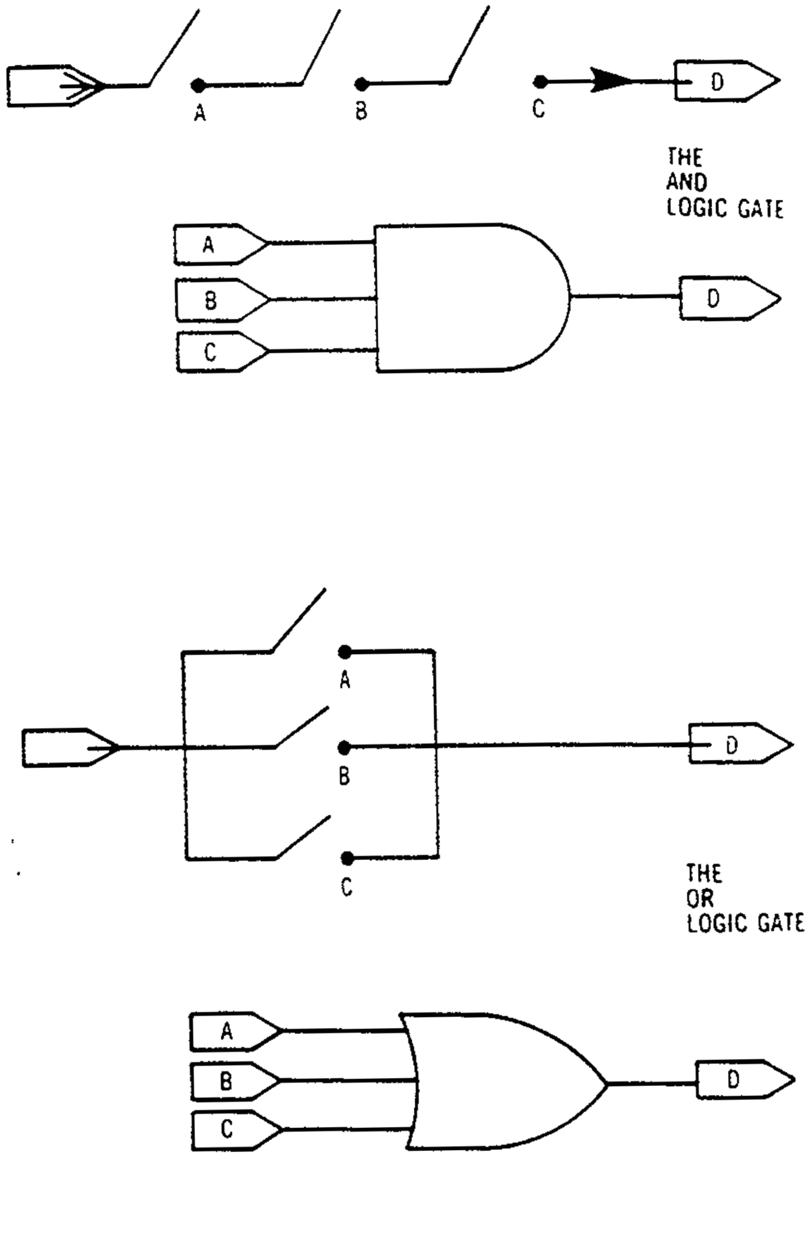
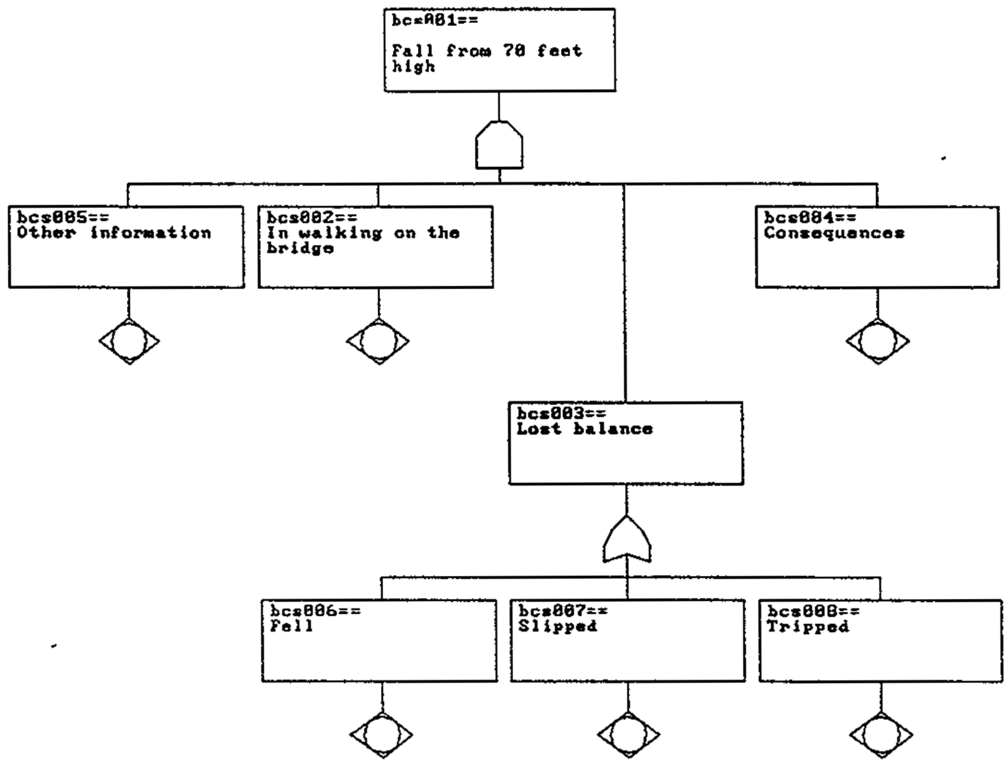
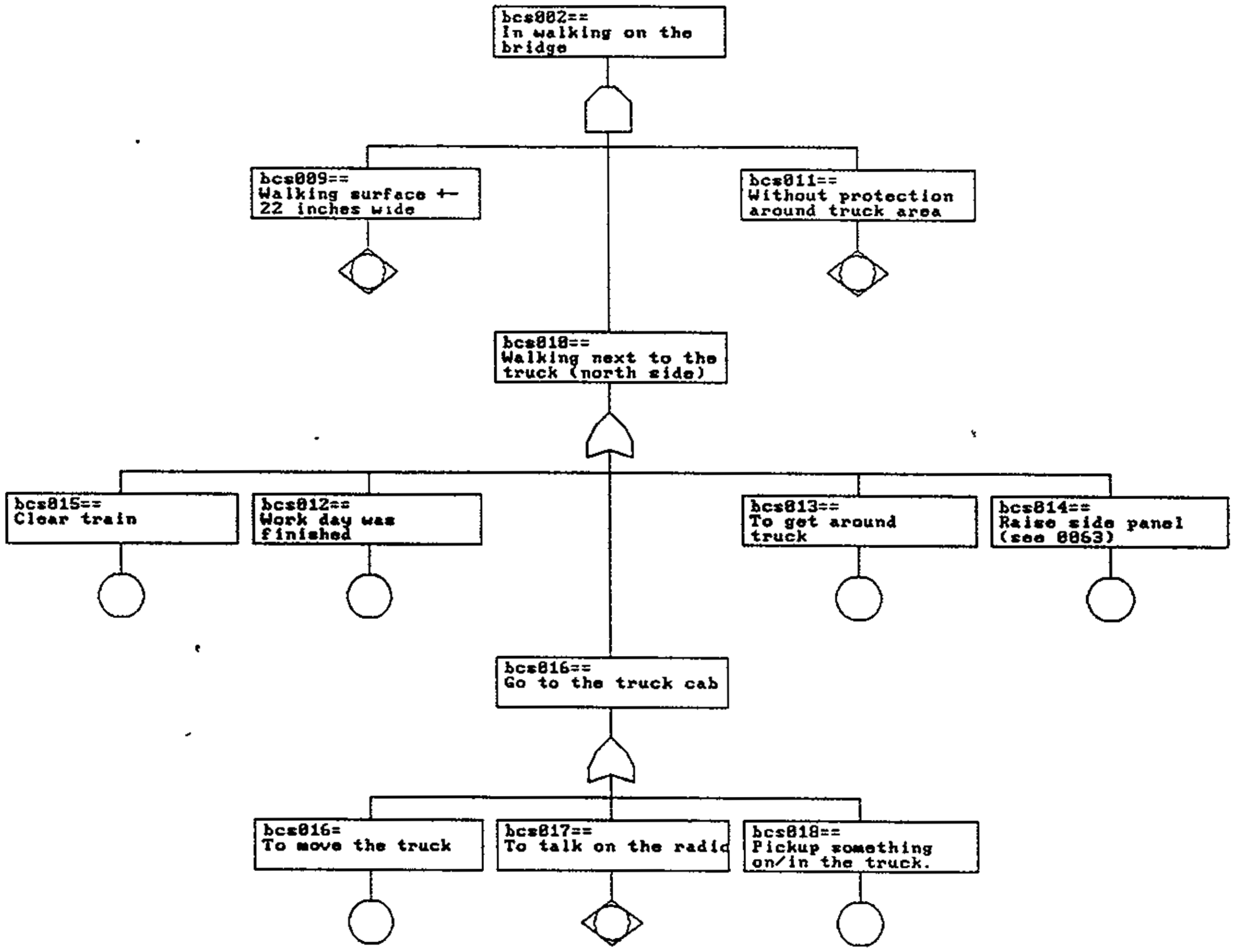


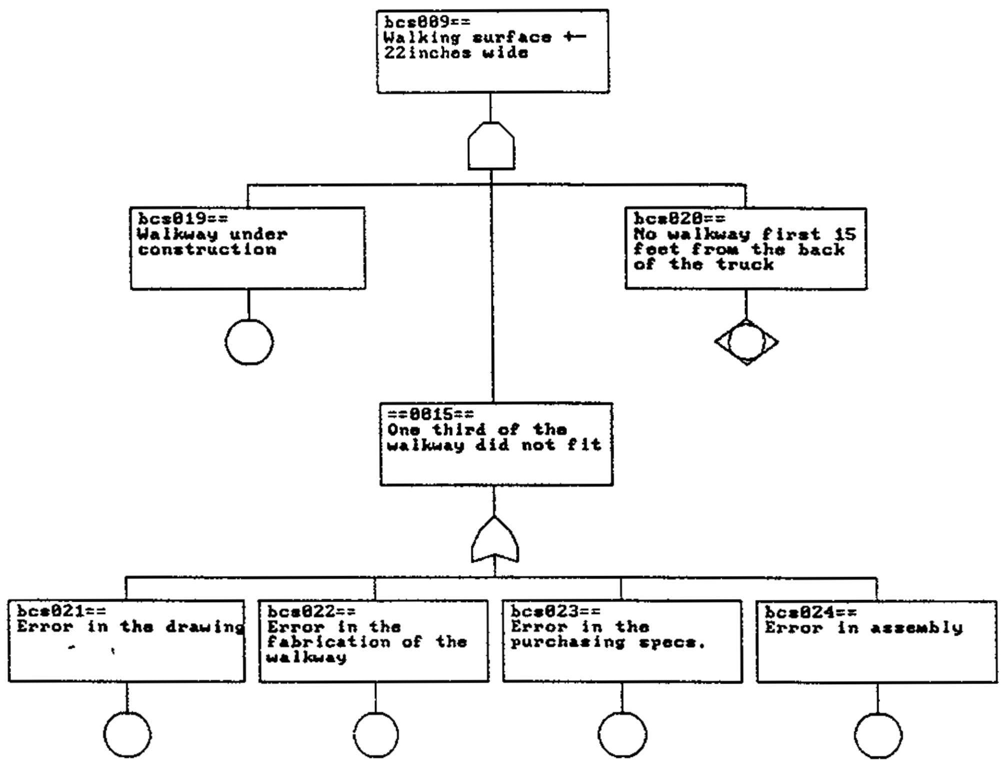
FIGURE 14-8 — LOGIC GATES

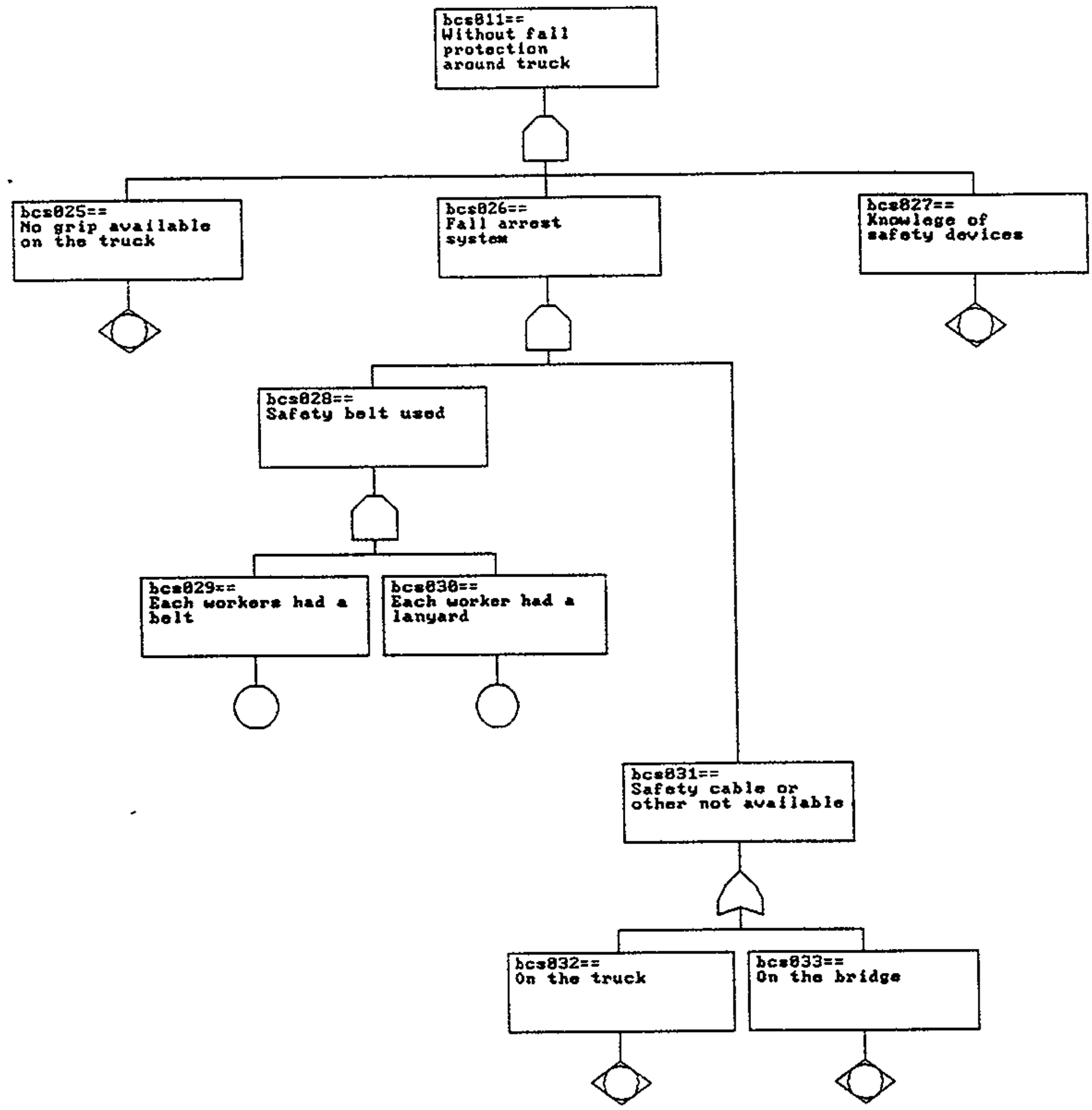


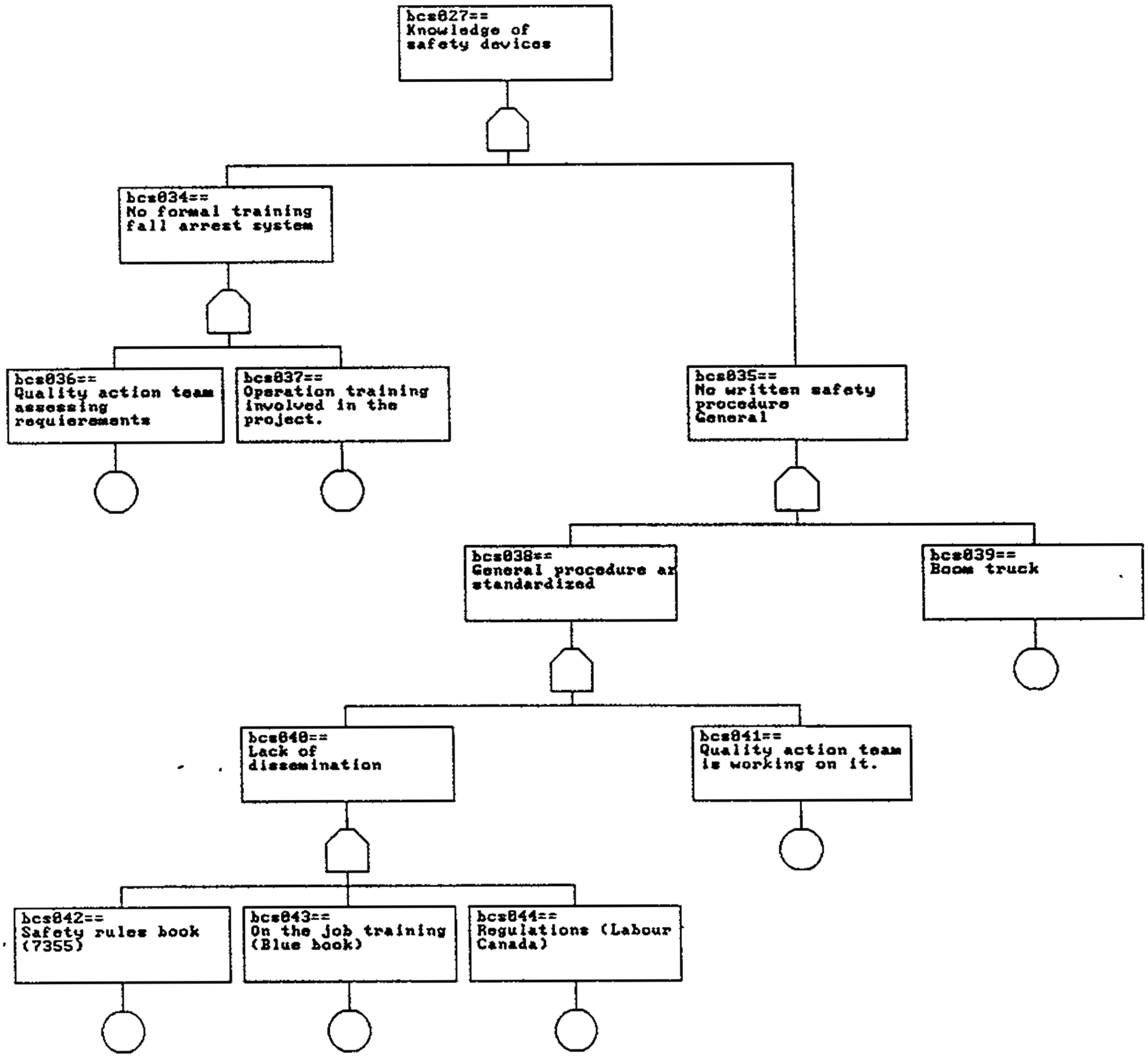
bcs001==
Fall from 70 feet high
bcs005==
Other information
bcs002==
In walking on the bridge
bcs004==
Consequences
bcs003==
Lost balance
bcs006==
Fell
bcs007==
Slipped
bcs008==
Tripped

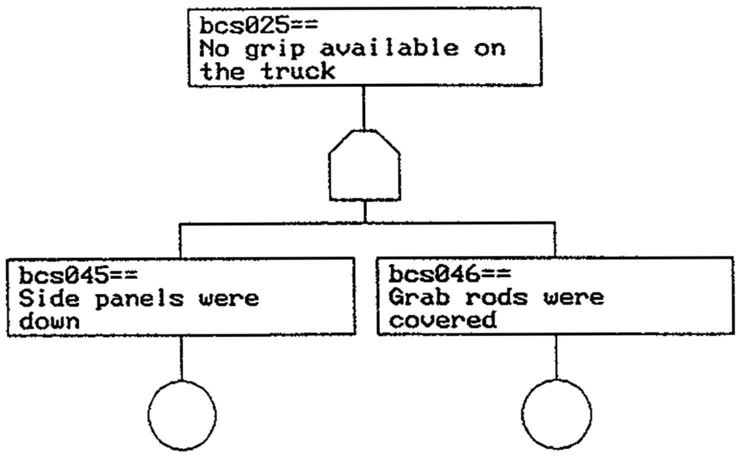
I

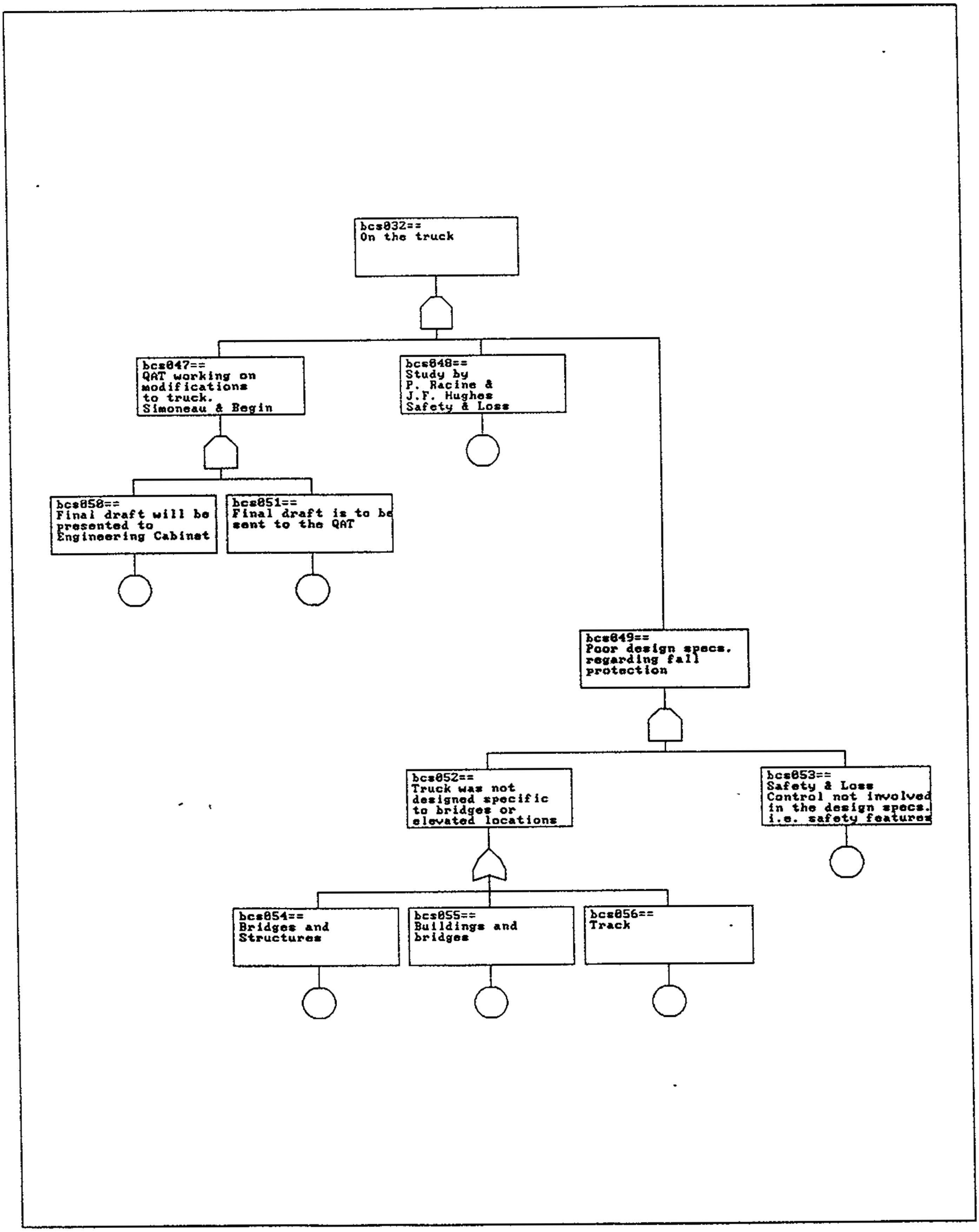

bcs002==
In walking on the bridge
bcs009==
Walking surface +-
22 inches wide
bcs011==
Without protection
around truck area
bcs010==
Walking next to the
truck (north side)
bcs015==
Clear train
bcs012==
Work day was
finished
bcs013==
To get around
truck
bcs014==
Raise side panel
(see 0063)
bcs016==
Go to the truck cab
bcs016=
To move the truck
bcs017==
To talk on the radic
bcs018==
Pickup something
on/in the truck.

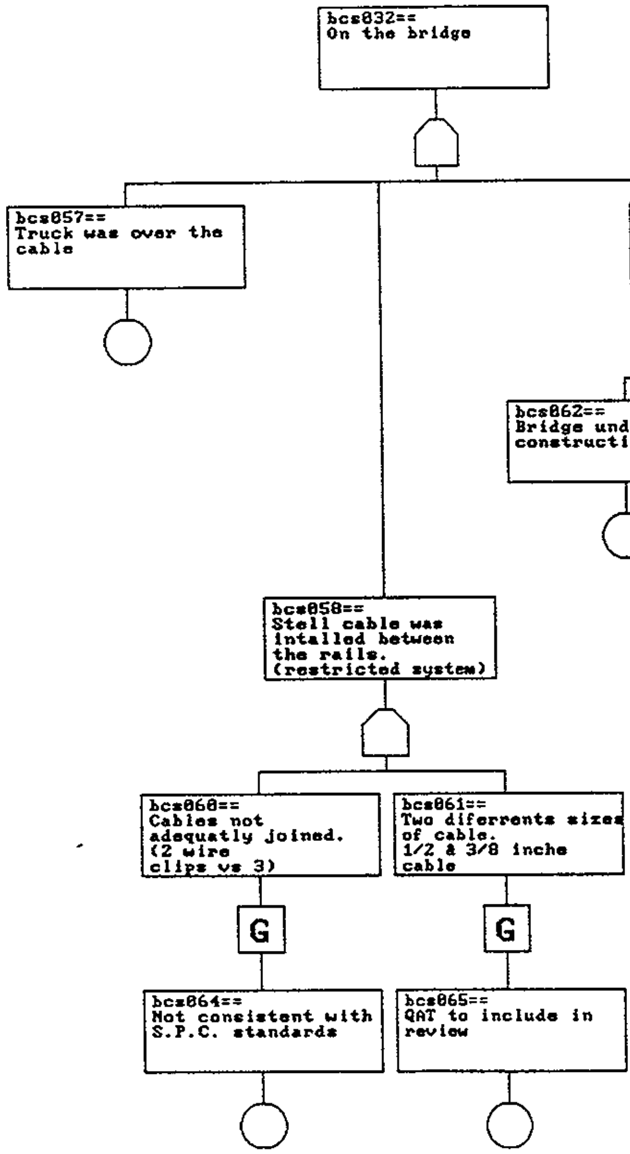

bcs009==
Walking surface +—
22inches wide
bcs019==
Walkway under
construction
bcs020==
No walkway first 15
feet from the back
of the truck
==0015==
One third of the
walkway did not fit
bcs021==
Error in the drawing
bcs022==
Error in the
fabrication of the
walkway
bcs023==
Error in the
purchasing specs.
bcs024==
Error in assembly


bcs011==
Without fall
protection
around truck
bcs025==
No grip available
on the truck
bcs026==
Fall arrest
system
bcs027==
Knowlege of
safety devices
bcs028==
Safety belt used
bcs029==
Each workers had a
belt
bcs030==
Each worker had a
lanyard
bcs031==
Safety cable or
other not available
bcs032==
On the truck
bcs033==
On the bridge

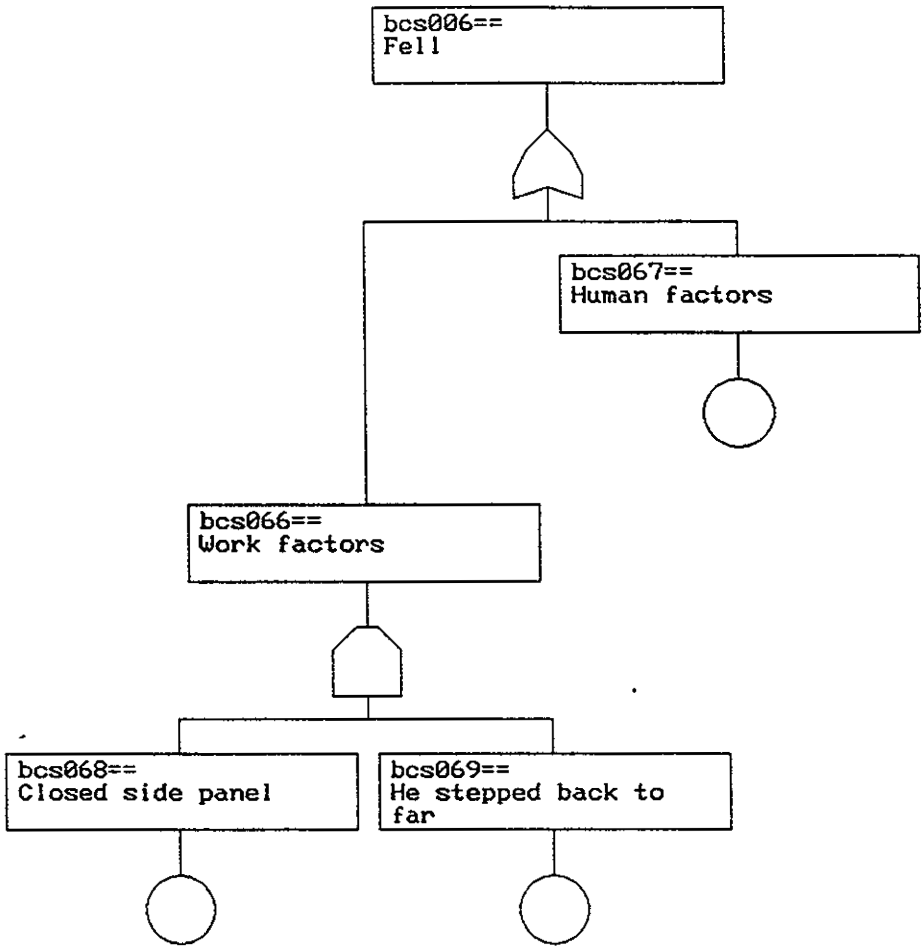

bcs027==
Knowledge of
safety devices
bcs034==
No formal training
fall arrest system
bcs036==
Quality action team
assessing
requierements
bcs037==
Operation training
involved in the
project.
bcs035==
No written safety
procedure
General
bcs038==
General procedure ar
standardized
bcs039==
Boom truck
bcs040==
Lack of
dissemination
bcs041==
Quality action team
is working on it.
bcs042==
Safety rules book
(7355)
bcs043==
On the job training
(Blue book)
bcs044==
Regulations (Labour
Canada)

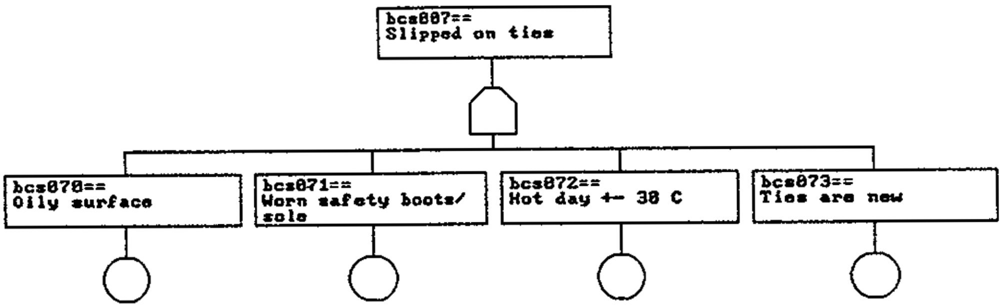

bcs025==
No grip available on the truck
bcs045==
Side panels were down
bcs046==
Grab rods were covered


bcs032==
On the truck
bcs047==
QAT working on modifications to truck. Simoneau & Begin
bcs048==
Study by P. Racine & J.F. Hughes Safety & Loss
bcs050==
Final draft will be presented to Engineering Cabinet
bcs051==
Final draft is to be sent to the QAT
bcs049==
Poor design specs. regarding fall protection
bcs052==
Truck was not designed specific to bridges or elevated locations
bcs053==
Safety & Loss Control not involved in the design specs. i.e. safety features
bcs054==
Bridges and Structures
bcs055==
Buildings and bridges
bcs056==
Track

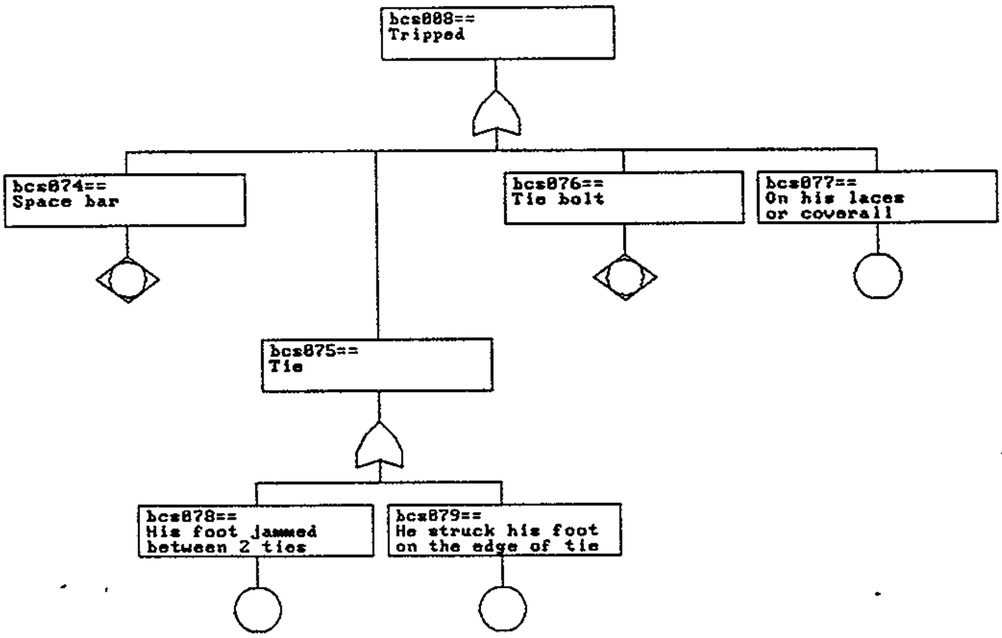


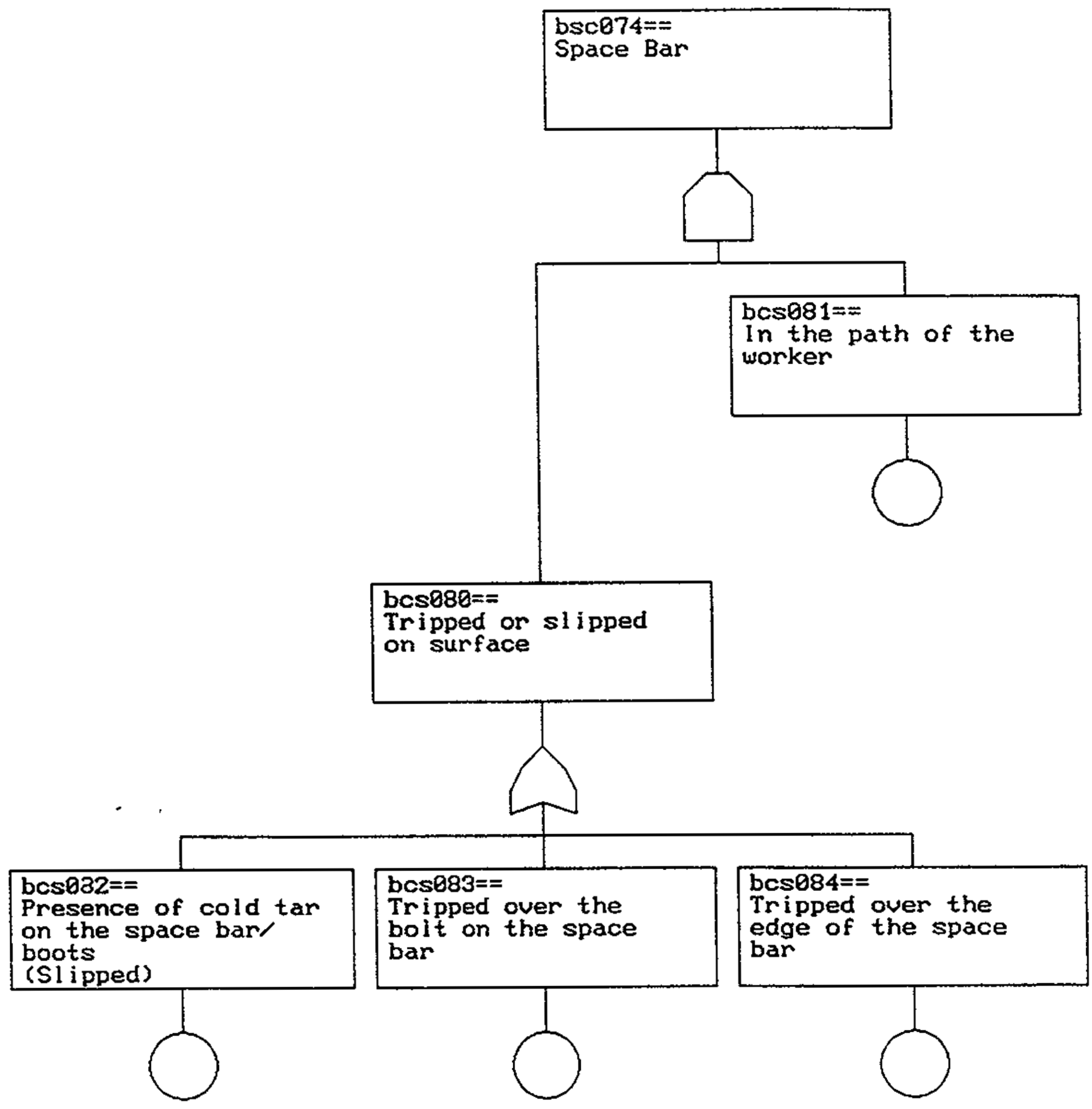
bcs032==
On the bridge
bcs057==
Truck was over the cable
bcs059==
Handrails
bcs062==
Bridge under construction
bcs063==
Handrails missing at the barrel stand
bcs058==
Stell cable was intalled between the rails.
(restricted system)
bcs060==
Cables not adequatly joined.
(2 wire clips vs 3)
bcs061==
Two diferrents sizes of cable.
1/2 & 3/8 inche cable
G
G
bcs064==
Not consistent with S.P.C. standards
bcs065==
QAT to include in review

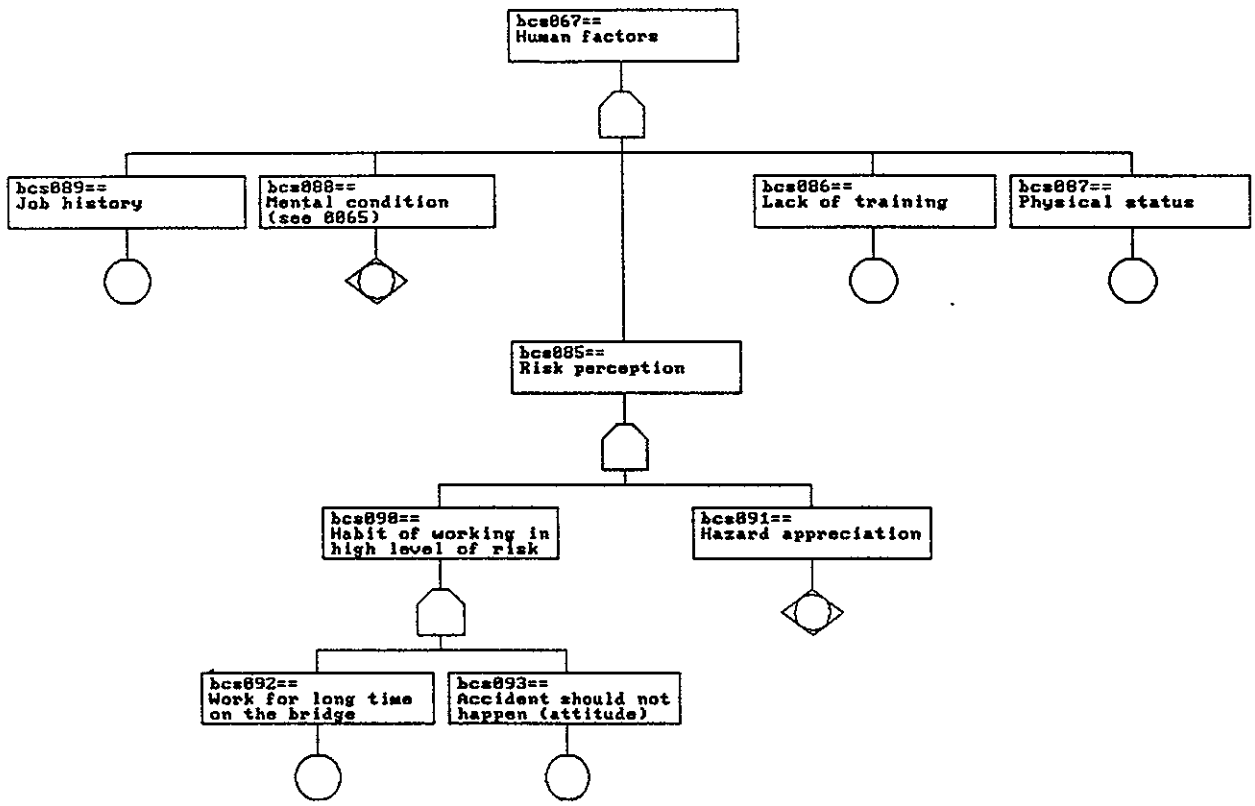

bcs006==
Fell
bcs067==
Human factors
bcs066==
Work factors
bcs068==
Closed side panel
bcs069==
He stepped back to
far

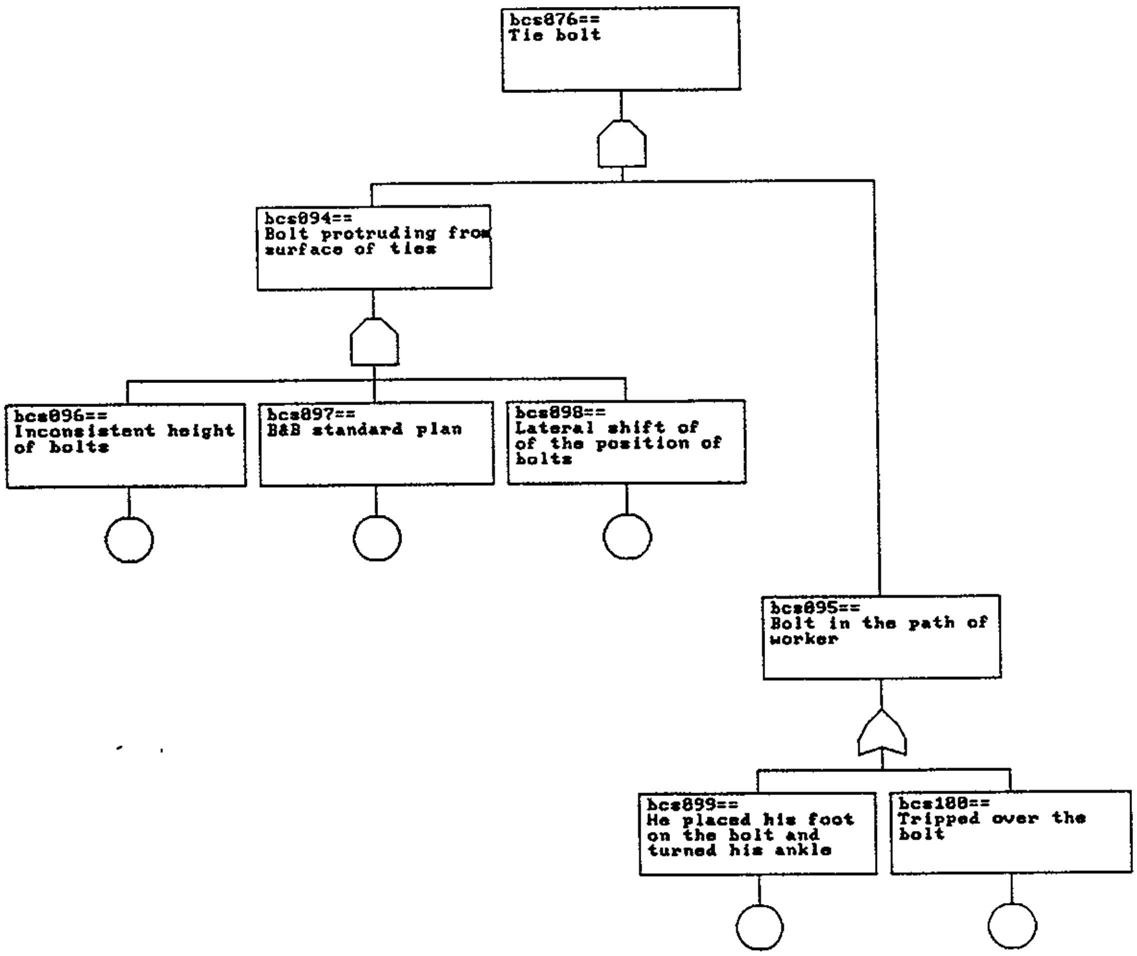

bcs007==
Slipped on ties
bcs070==
Oily surface
bcs071==
Worn safety boots/
sole
bcs072==
Hot day +- 30 C
bcs073==
Ties are new

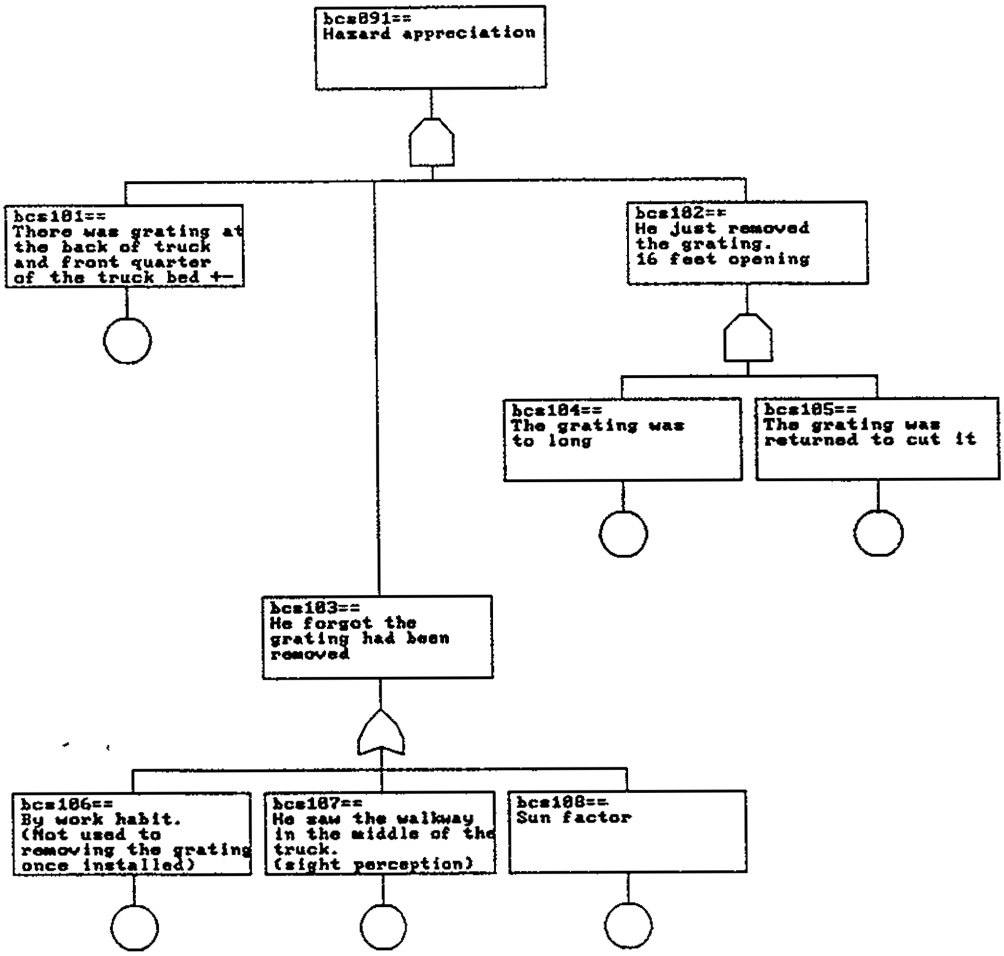
10


bcs088==
Tripped
bcs074==
Space bar
bcs075==
Tie
bcs076==
Tie bolt
bcs077==
On his laces
or coverall
bcs078==
His foot jammed
between 2 ties
bcs079==
He struck his foot
on the edge of tie

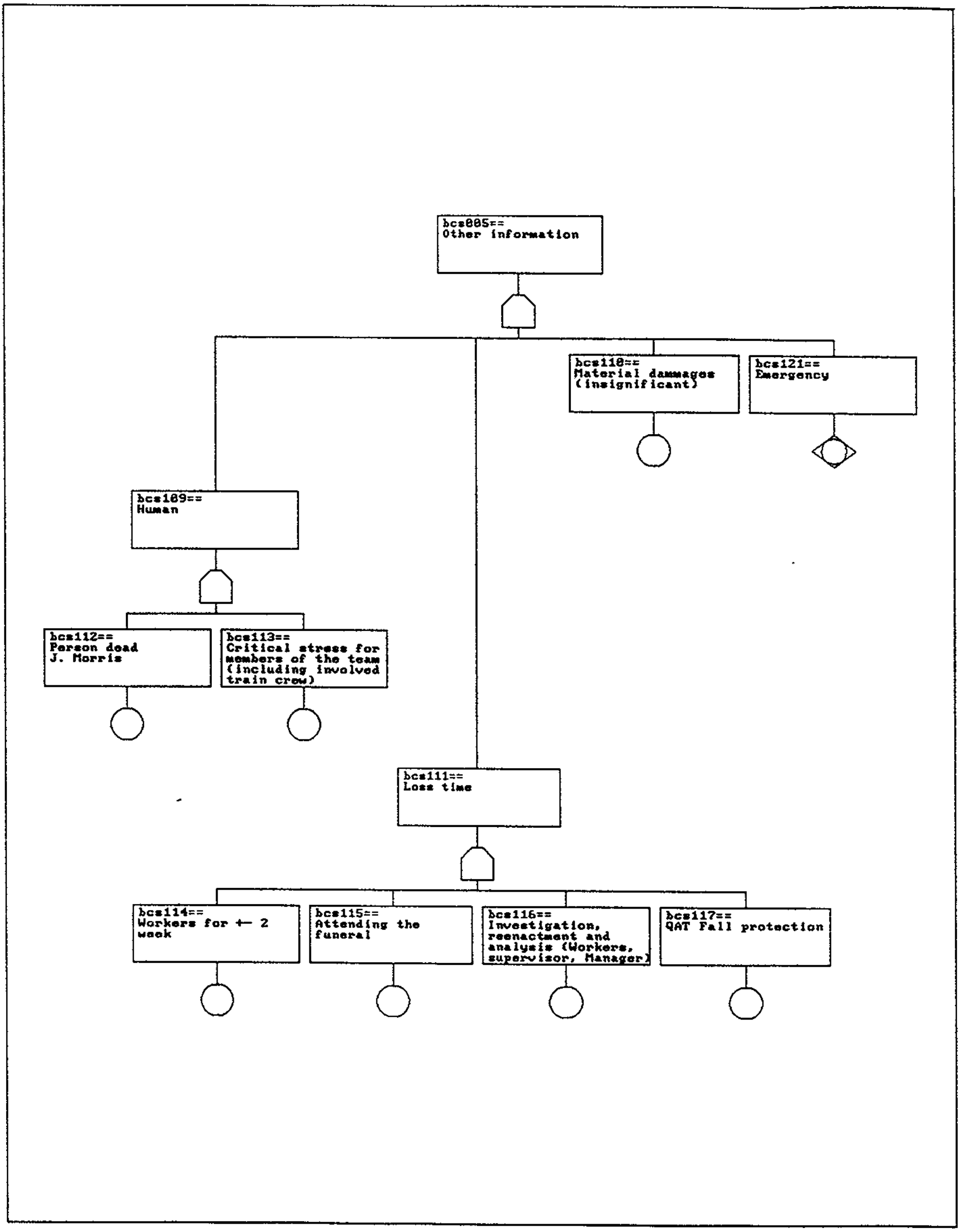

bsc074==
Space Bar
bcs081==
In the path of the worker
bcs080==
Tripped or slipped on surface
bcs082==
Presence of cold tar on the space bar/ boots (Slipped)
bcs083==
Tripped over the bolt on the space bar
bcs084==
Tripped over the edge of the space bar

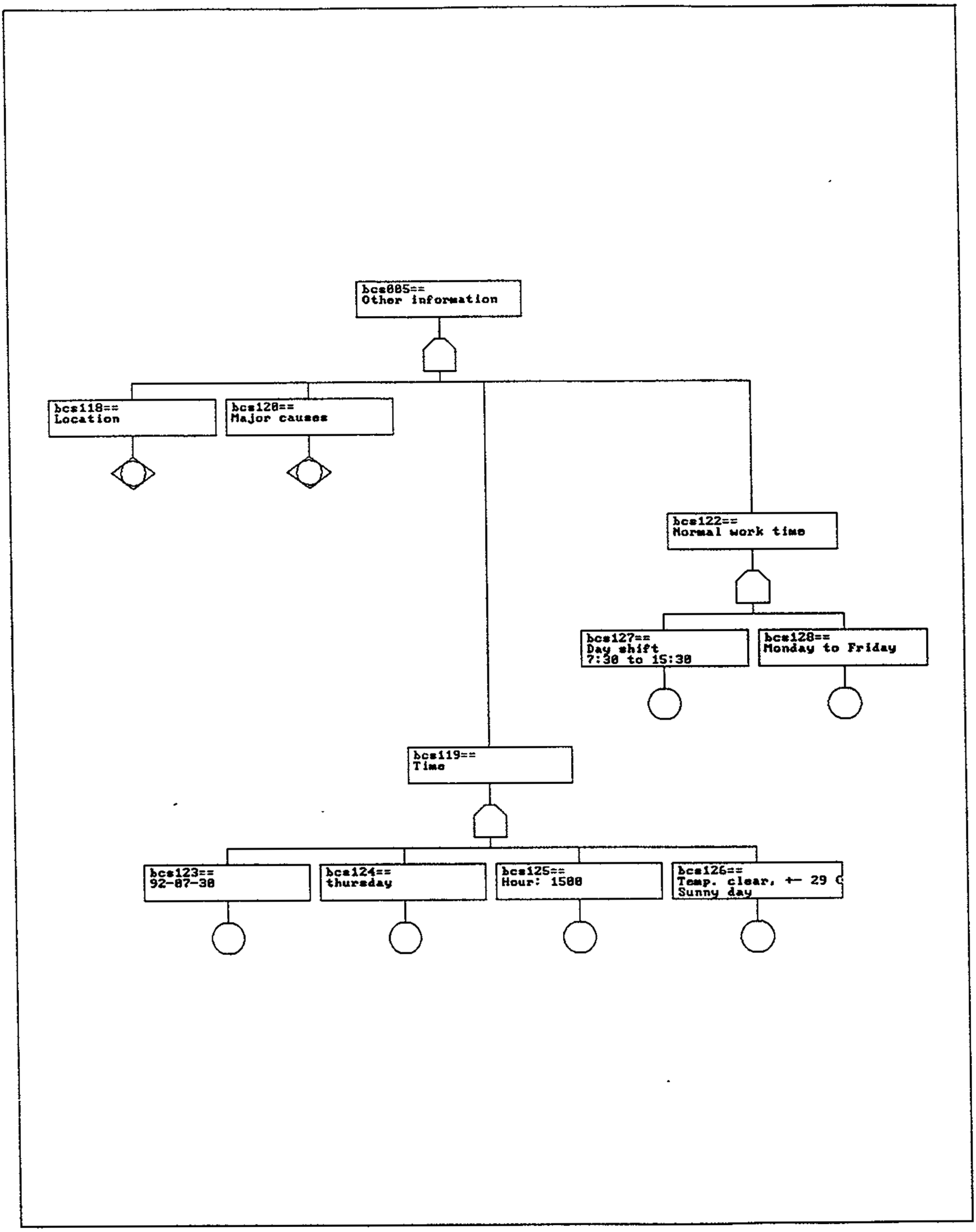

bcs067==
Human factors
bcs089==
Job history
bcs088==
Mental condition
(see 0065)
bcs086==
Lack of training
bcs087==
Physical status
bcs085==
Risk perception
bcs090==
Habit of working in
high level of risk
bcs091==
Hazard appreciation
bcs092==
Work for long time
on the bridge
bcs093==
Accident should not
happen (attitude)


bcs876==
Tie bolt
bcs894==
Bolt protruding from surface of ties
bcs896==
Inconsistent height of bolts
bcs897==
B&B standard plan
bcs898==
Lateral shift of of the position of bolts
bcs895==
Bolt in the path of worker
bcs899==
He placed his foot on the bolt and turned his ankle
bcs180==
Tripped over the bolt

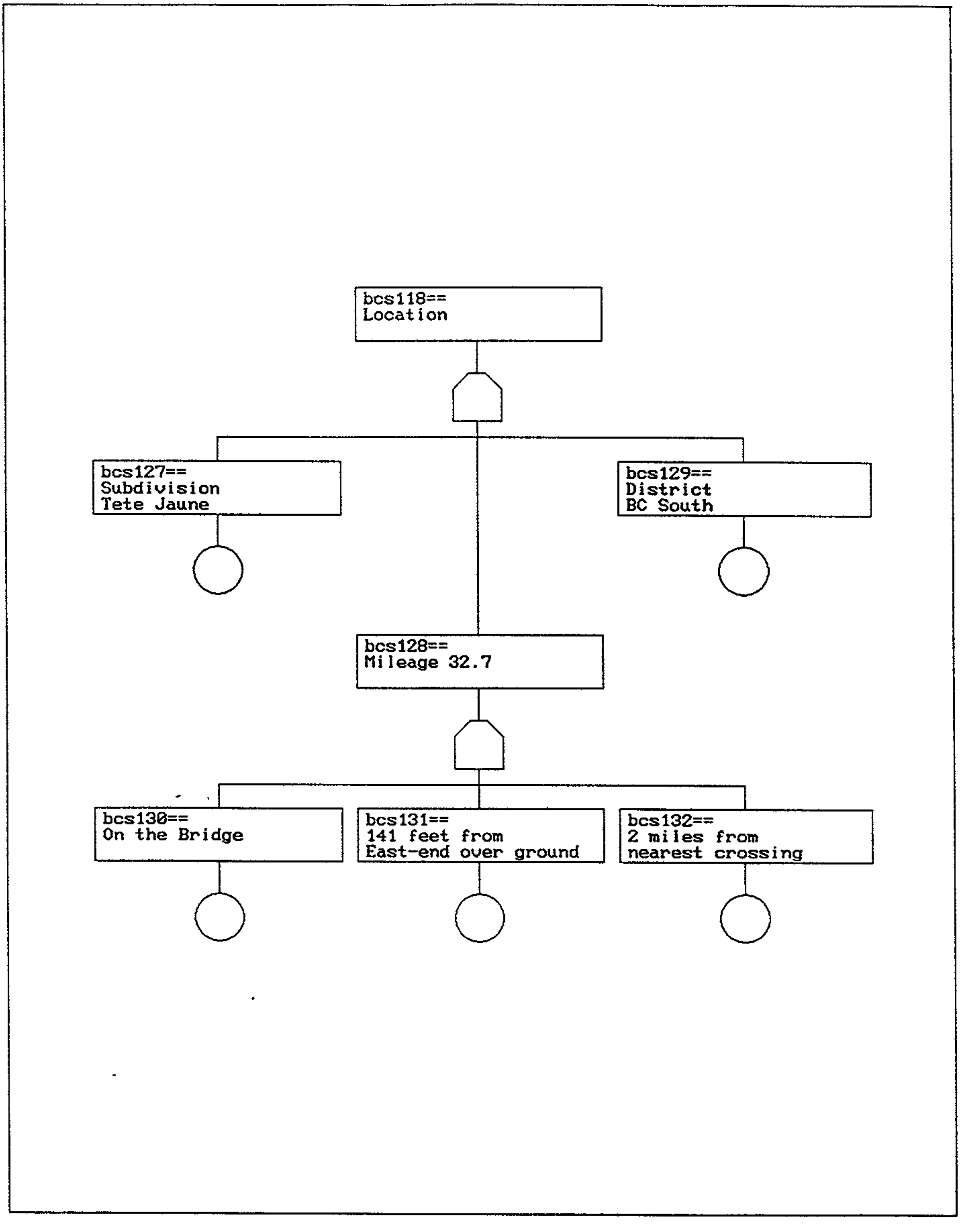


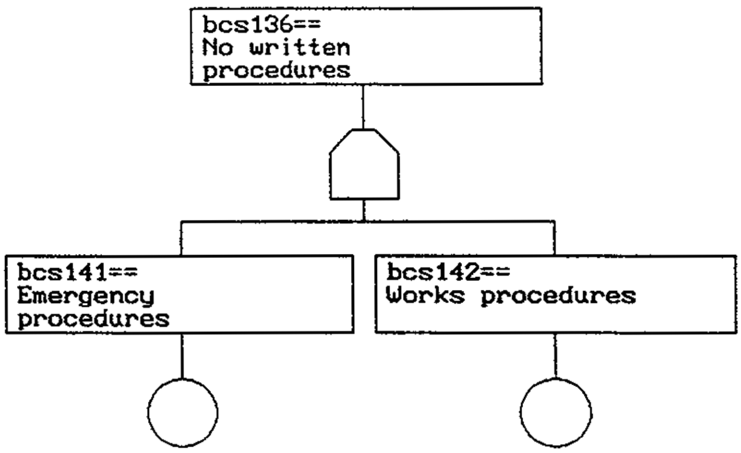
bcs091==
Hazard appreciation
bcs101==
There was grating at the back of truck and front quarter of the truck bed +-
bcs102==
He just removed the grating.
16 feet opening
bcs104==
The grating was to long
bcs105==
The grating was returned to cut it
bcs103==
He forgot the grating had been removed
bcs106==
By work habit.
(Not used to removing the grating once installed)
bcs107==
He saw the walkway in the middle of the truck.
(sight perception)
bcs108==
Sun factor

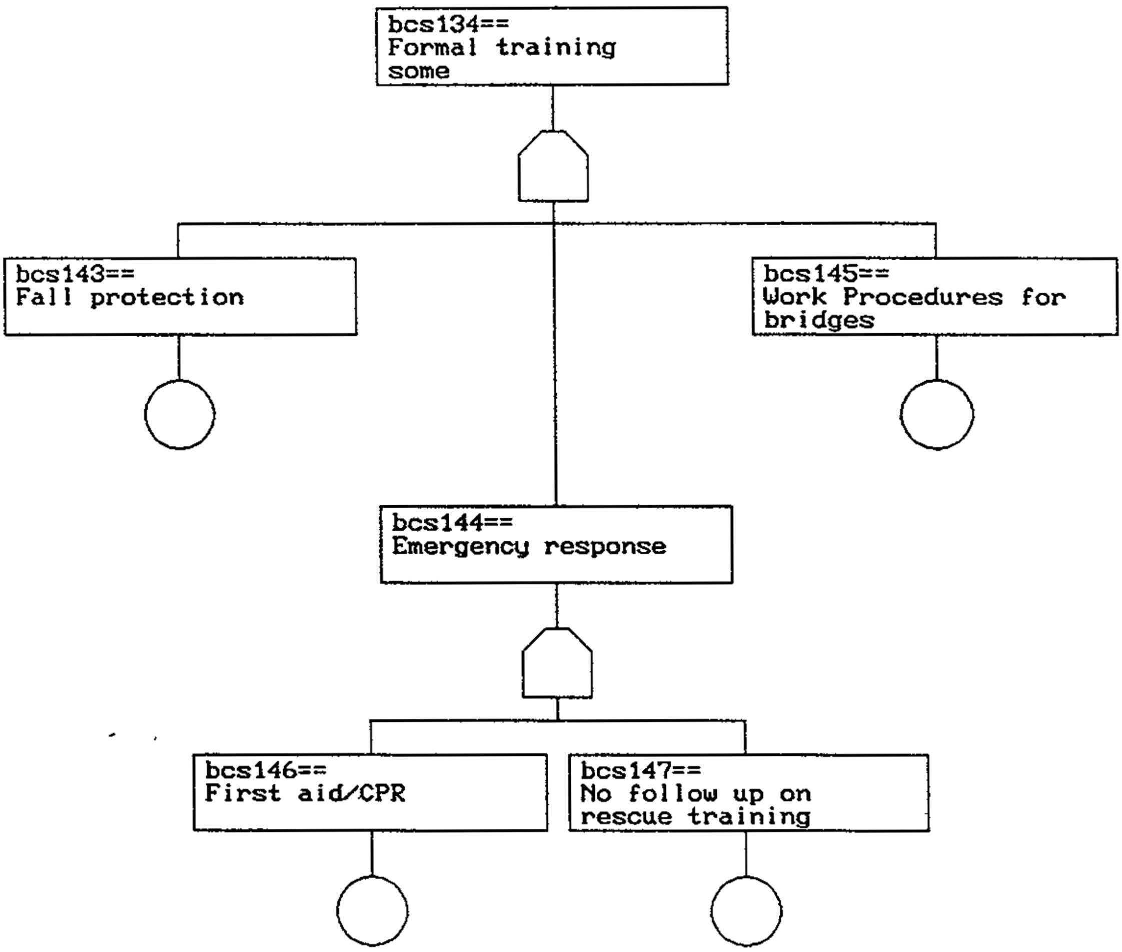

bcs005==
Other information
bcs110==
Material dammages (insignificant)
bcs121==
Emergency
bcs109==
Human
bcs112==
Person dead J. Morris
bcs113==
Critical stress for members of the team (including involved train crew)
bcs111==
Loss time
bcs114==
Workers for +- 2 week
bcs115==
Attending the funeral
bcs116==
Investigation, reenactment and analysis (Workers, supervisor, Manager)
bcs117==
QAT Fall protection

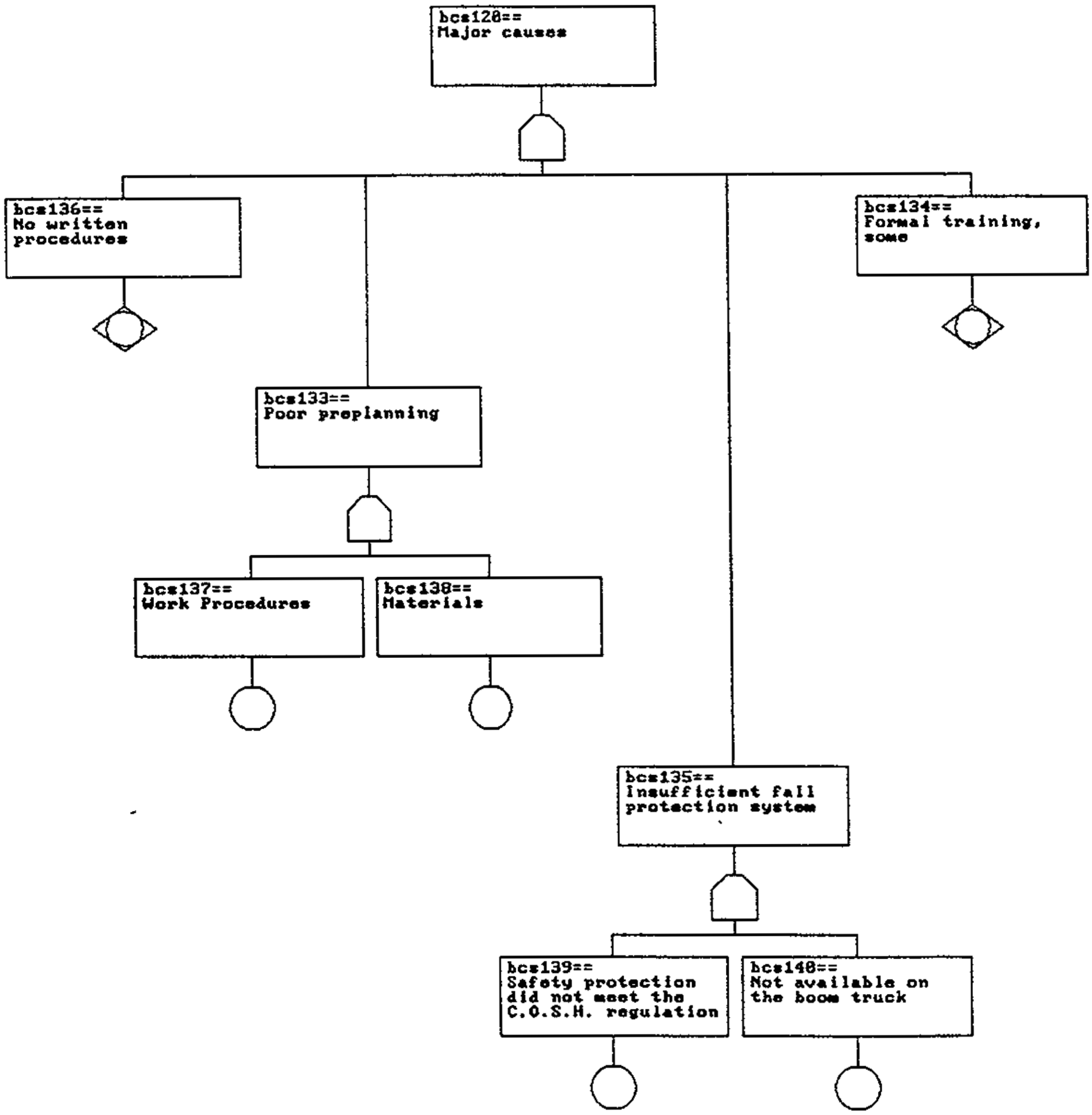


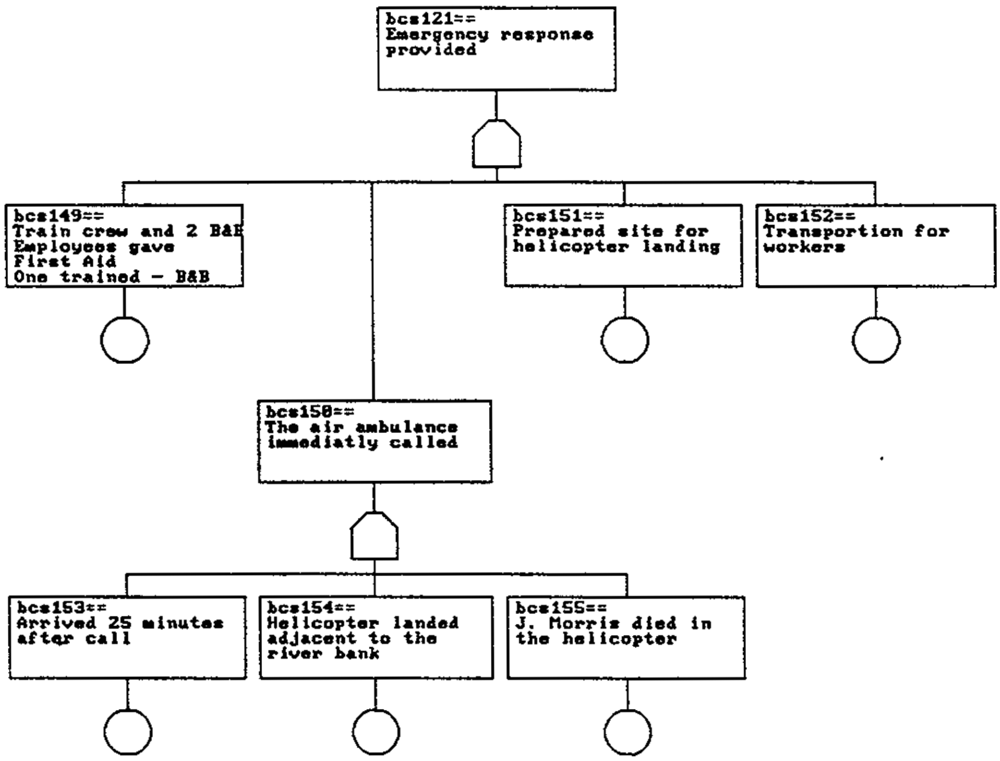
bcs005==
Other information
bcs118==
Location
bcs120==
Major causes
bcs122==
Normal work time
bcs127==
Day shift
7:30 to 15:30
bcs128==
Monday to Friday
bcs119==
Time
bcs123==
92-07-30
bcs124==
thursday
bcs125==
Hour: 1500
bcs126==
Temp. clear, +- 29 C
Sunny day


bcs118==
Location
bcs127==
Subdivision
Tete Jaune
bcs129==
District
BC South
bcs128==
Mileage 32.7
bcs130==
On the Bridge
bcs131==
141 feet from
East-end over ground
bcs132==
2 miles from
nearest crossing


bcs136==
No written
procedures
bcs141==
Emergency
procedures
bcs142==
Works procedures


bcs134==
Formal training
some
bcs143==
Fall protection
bcs145==
Work Procedures for
bridges
bcs144==
Emergency response
bcs146==
First aid/CPR
bcs147==
No follow up on
rescue training


bcs128==
Major causes
bcs136==
No written procedures
bcs134==
Formal training, some
bcs133==
Poor preplanning
bcs137==
Work Procedures
bcs138==
Materials
bcs135==
Insufficient fall protection system
bcs139==
Safety protection did not meet the C.O.S.H. regulation
bcs140==
Not available on the boom truck


bcs121== Emergency response provided
bcs149== Train crew and 2 B&E Employees gave First Aid One trained - B&B
bcs150== The air ambulance immediatly called
bcs151== Prepared site for helicopter landing
bcs152== Transportion for workers
bcs153== Arrived 25 minutes after call
bcs154== Helicopter landed adjacent to the river bank
bcs155== J. Morris died in the helicopter

The necessity of incorporating the cognitive aspect in accident investigation

■ *SUMMARY & CONCLUSION*

- *The cognitive aspect is one aspect often overlooked during accident investigation.*
- *The main reason -- It is not readily apparent.*
- *The accident referred to in this presentation demonstrates a new facet to be included in accident investigations.*
- *The manner in which a person treats the information available depends on a series of factors which are interrelated.*
- *Understanding the process of treating information related to a specific task will contribute to providing clearer instructions, which will result in a safer more productive operation.*

International Rail Safety Conference

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9320

Gerald Churchill

Qualification of safety's jobs at the RATP company

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

QUANTIFICATION OF SAFETY'S JOBS AT THE RATP COMPANY

Gérard CHURCHILL

General Management
Dependability Responsible
RATP

QUANTIFICATION OF SAFETY'S JOBS AT THE RATP (Paris Transport Authority) THANKS TO PLANT EXPERIENCE FEEDBACK

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With the continuously increasing complexity of systems, combined to the major concern of the RATP to guarantee safe transportation. the company strove to consider man as part of the system, in the same way as equipment or software. all the more so as statistical enquiries show that man is directly implicated in more or less every accident or near accident.

Thus, from this postulate. considering that man can be as well "failure cause", "remedial loop" and especially that man is perfectible. thoughts and studies made by the company turned towards two directions:

- the qualitative analysis of human error
- the quantification of that error

As nowadays. in the present economic situation, difficult. when paradoxaly transport cost has to be very low and simultanuously safety level has to be very high, major role of these studies is marked by both the specificity of railway jobs and the importance of those jobs linked to transport safety.

1. Qualitative analysis

1.1 Goal

Understanding the mecanism that leads to an error must permit to propose corrective actions to limit or remove the possible appearance of the analysed error.

1.2 Method

The subtle understanding of the error mecanism relies on a data capture form (also called accident form) and on an analysis form.

The data capture form, which is peculiar to each type of the considered job (driver, regulator, repairer...) is a local tool, used right after an event. comprising all the information that can be immediately caught.

Whatever the job, information of this data capture form must permit to fill up the analysis form which is common to all the jobs. The latter looks like a grid of events concerning different headings directly linked to the stage. the type and the cause of failure as well as the type of behaviour peculiar to man.

As the whole set of all these qualitative works is strongly inspired by the ones made by the SNCF. this subject won't be further developed.

2. Quantitative analysis

2.1 Goal

RATP's doctrine towards safety goals consists, whenever it is possible, in specifying them into quantitative terms. Acceptance of a system relies in particular on the monitoring of the respect of these goals by quantitative analysis methods (for example Fault Trees) in which man is considered as an element of the system.

While quantification of an equipment reliability is quite easy to do as rates of failures are well known, situation is definitely different for man.

As to human reliability, plentiful litterature does exist that gives absolute failure probabilities spreading from 10^{-5} to 10^{-1}, or 1 in some cases. As a general rule, 10^{-3} would be used, without justification except the fact that this value turned out to be the currently admitted equivalent of a barrier in the case of safety. Facing this problem, an attempt of quantification has been done for a few safety's jobs peculiar to the company.

2.2 Method

Firstly, a special study concerned 3 jobs which are:

- the driving of a metro;
- the current connecting and current cutting by a regulator;
- corrective maintenance in the field of signalling.

2.2.1 The driving of a metro

A first study was based on the untimely crossing of normally absolute stop signals, on a given line and on a given period (year 1992). This study called on statistical methods and allowed with a 95% confidence level to have quite a precise idea of the human error probability that can lead to this crossing.

2.2.2 Current connecting and current cutting

This second study concerned a regulator's error at the PCC (Centralized Traffic Control Room) during nightly operatings of permit to work when there are some works or trials (1991 was the reference year).

Like the previous study, the error probability has been estimated calling on statistical methods at a 95% confidence level.

2.2.3 Corrective maintenance in the field of signalling

At last, a third study was made, concerning corrective maintenance errors on signals plants, spreading on two consecutive years (1991-1992). Contrary to the previous studies, as the exact number of interventions during that period was known, the error probability has been estimated without refering to statistics.

3. Conclusion-Subsequent studies

Although obtained results make reference to very few examples, comparisons on these examples make it credible, at least in a first step, to give two values for safety's jobs; these values are not linked to the work itself but to the type of the task. whether it is a "single task" or a "complex task".

Single task: $P = 3.10^{-5}$

Complex task: $P = 2.10^{-4}$

These values calculated from real data. obtained from plant experience feedback. take in account the whole set of normally faced situations. including period of stress. contrary to laboratories trials where situations can be artificially simulated in independent ways.

These figures. that must be used cautiously, have to be strengthened by supplementary studies talking of:

- other works;
- other examples of the already treated jobs (the driving of a metro on a longer period for example...).

International Rail Safety Conference

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9321

Hirokazu Miki

Factors of running-over accidents involving subcontractors's workers

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

FACTORS OF RUNNING-OVER ACCIDENTS INVOLVING SUBCONTRACTORS'WORKERS

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Factors of Running - over Accidents Involving Sub-contractors' Workers

By Hirokazu MIKI
EAST JAPAN RAILWAY WORKERS' UNION

1 Outline of fatal accidents

(1) Accident Report (1987 to 1993)

In April 1987 former JNR privatised and East Japan Railway company (JR East) started business. Afterwards, the business has grown steadily and it lists the stocks on the Tokyo Stock Exchange in this autumn. This is the fruit of an all-out effort of employers and union.

The present transportation scale of JR East is about as follows.

Train Kilometers		276 millions (1992/3)
Passenger Kilometers		128.5 billions (1992/3)
Number of Trains (1 day)		
Total	12,186	
Shinkansen lines	208	
Other lines	11,978	
Number of Passengers (1 day)	17 millions	

The train accident has greatly decreased from 376 of 1987/8 (Fiscal year begins from April and ends to March in Japan) to 210 of 1992/3 (Chart 1). This decrease is supposed to owe to our serious effort on safety and the safety investment, which amounts to 4 billion U.S. dollars from 1988 to 1993 fiscal year.
The train accidents surely decrease but the fatal accidents involved in track and electricity maintenance workers, whose work is indispensable to the operation, do not decrease.

Chart-2 shows the number of the fatal accidents involved in sub-contractors' workers from 1997/8 to 1993/4 (1993/4's figure is April to September). In 1987/8, the first year of new company, the fatal accidents were six and six workers were killed but for the next two years they dramatically increased.

In such situation East Japan Railway Workers' Union (JREU) tackled the safety issue seriously. JREU set out "Union Policy Forum" to discuss our policy and propose the alternative plan in 1988. In 1989 we studied and discussed the accident prevention and safety measures in "Union Policy Forum". Then in 1990 we held the "International Railway Safety Conference" in Tokyo and discussed with world railway unions and management. After these events the fatal accidents were reduced to only one (one death) in 1991/2. But we had seven accidents (nine deaths) in 1992/3 and three (five deaths) for the first six months in 1993/4.

There is a wave motion in the accident number in every fiscal year, though it is necessary to watch the transition in the future.

(2) The causes of fatal accidents

The causes of the accidents that happened for the latest six and a half years are that running - over comes first, fall second, electric shock third and others last. The number of running - over accidents is 21 out of 46 (45 7%) and the number of deaths caused by it is 29 out of 54 (53 7%). Recently, several serious accidents happened; four workers were killed at a time in November 1988 when they began preparation work in tracks without confirming a train's coming. Afterwards, two in March 1990, three each in March and June 1993 were killed at a time by running - over accidents.

Considering such cases I would like to examine the factors of running - over accidents.

2 Ordering and Working System of Track Maintenance

(1) Sub-contract system

The maintenance work, such as railway tracks, has been sub-contracted since Japanese National Railway's age. Employees in JR East cover a part of jobs except for inspection. Especial heavy Libra jobs are done by sub-contracted workers.

There are several ten companies that undertake the maintenance work. They are called "co-operation company". The maintenance work of railway tracks and electricity is largely owing to them in JR East. Usually a co-operation company employs about 100 to 300 workers and is, of course, an independent corporation. Many managers and workers of JR East get a job in it after their retirement.

In practice the employees in the co-operation company are responsible for the work as a site deputy, chief engineer and site manager. But co-operation company does not send their own workers in many cases It contracts with other small sub-contract business who always undertake their work from co-operation company.

The co-operation company not only gets orders from JR East and gives it to the subcontract company but also provides the safety and technology education, and helps it financially.

The order of maintenance work from JR East isn't given throughout the year constantly. Although in the beginning of fiscal year the amount of order is not much, it increases greatly in the end. This tendency is improved a little now compared with the JNR era.

(2) Work system

The workers in the sub-contract company undertake actual work in railway tracks and electric facilities. The sub-contract company is usually so small, has about 10 to 30 workers, that the boss himself has to work sometimes. A party of workers consists of a site manager, a foreman and workers. It is about ten. When they work along tracks that are in service a train-watcher is required at the site The site manager is responsible for controlling of construction work.

It is prohibited in Japan by law that the first contractor (co-operation company) passed the whole order to the third company (sub-contract company). Therefore the site manager is always the employee in the co-operation company. He conducts and supervises subcontractors' workers. The train-watcher is appointed among workers and he has to devote himself to watch trains without doing other jobs.

The workers' salary of the sub-contract company depends on how many times they work a month, that is, the daily wages accumulate for a month and we call it "Daily wage salary". There are many workers who want to work both at daytime and at night to increase the income.

When they work in the tracks that are in service, they have to submit a work plan to the site-controlling office of JR East and discuss the timetable of trains. Occasionally an employee of JR East inspects the work, but in most cases the co-operation company directs the work.

(3) Requests from co-operation company

The standpoint of co-operation company is weak of course in the relation between the purchaser and contractor though it is equal in the legal term. As a result this relation tends to inhibit the co-operation company from requesting its demands to JR East. JREU and unions in co-operation companies formed the federation organization, called "JR HIGASHI ROREN" and have made an effort as the same workers aiming at solving the problem.

The union leaders in the co-operation companies requested us following matters, when we talked about the running-over accidents.

First, they told us that contracted work should be at the same level through the year. Since the construction order is not level, there are actually two seasons, busy and idle, however. When a lot of order is undertaken at a time they become busy and it is very difficult to recruit workers. So they have to work by eight instead of 10 workers being under the risk, which affects safety measure. When there is not enough work and such period continues for long time the workers cannot get salary sufficiently and they move to another job sometimes. Moreover the tension which is required at work to keep safety cannot be maintained.

Next, they told us a technological development should be introduced They hope that safety equipment, for instance a handy train approach warning machine, will be introduced to keep safety not depending on only train-watcher's attention. In the past it has been introduced but needs a cable and takes a time to connect to it, so it was not convenient to use. However, the train approach warning machine of wireless type to which even the train number can be identified is tried aiming at practical use in two lines recently

The third request they told us is to make good circumstances that JR East and the co-operation companies can talk about anything concerned frankly. The co-operation compan as a contractor still cannot speak to the JR East as a purchaser. When an accident happens once, the co-operation company is usually blamed one-sided and JR East requests the plan of new accident prevention measures to the co-operation company. As a result, the measures become complex and it is difficult to execute in the work place. They requested the simplification of measures and to make a good circumstance in which they could discuss every thing with JR East.

In addition, they also requested the mechanization of work and introduction of new machines to improve their workers' environment. In Japan young people dislike dirty Libra work, such as maintenance work in railway tracks. The present workers have become old between 50's and 60's in average. The shortage of work force is a serious problem for them and mechanization is assumed to solve it and promote workers' generation change.

3. Recent two accident cases

(1) Case A - Mito Station Accident

Three rail-track maintenance workers were killed in Mito Station, which was in 120 km north from Tokyo, at 1:03 am on 3rd March 1993. Their duty at that night w. to install automatic oiling devices to the points. As the working team finished its scheduled work earlier, they began to install the device to the another points that was not on their working plan.

Usually there was no train in that time-zone but unfortunately the express train delayed and the freight train which was due to arrive later, came into the station earlier than the express. The freight train came into the platform that the express was due to arrive. The express delayed by some 30 minutes. It arrived at the platform next to the freight train and started soon afterward. Just after it started from the station the accident happened at the 321 A Point.

The site manager was an employee in JR East who was on loan to the co-operation company at that moment. He had worked in the local maintenance office for about 20 years, so he thought he knew well about the station yard including time table. However, the train-watcher did not notice the express running toward them because the freight train stopped at the platform where the express was due to arrive. As a result, the site manager and two workers were run over and killed.

(2) Case B - Kashimadai Station Accident

The accident occurred at 2.37 am on 19 June 1993 in Kashimadai Station, 370 km north from Tokyo. Three workers were killed at a time

The site manager had to leave the site to take a camera leaving the message that the workers should not begin to work until the maintenance car arrives. Despite the message the foreman directed the workers to start the work, after asking the train-watcher whether the last train has passed. The train-watcher consulted timetable copied wrongly. According to the timetable, the final train had already passed there. The foreman had started before the site manager came back. What was worse, they carried tools and materials turning their back on the coming train. Then the accident happened. The train-watcher barely escaped but three workers were killed by the train

4 Examination

(1) A cycle of fatal accidents

In 1987/8, the first fiscal year of JR, we had six fatal accidents and six workers were killed. For the next two years they increased in proportion to the rise of the contract work (chart 3). In 1989, JREU started the railway safety campaign and in 1990 we had the International Railway Safety Conference in Tokyo co-sponsored by the management. Through these activities we have established the concept that we should not blame the worker's responsibilities, we should clear up the cause of the accidents.

JR East also set out the Challenge Safety campaign. As a result, after 1990/91, the number of the accidents dramatically decreased. Especially, the fatal accident in 1991-92 was only one. But it went up again from 1992/3 and for the first half of 1993/4 three fatal accidents have already happened.

Chart-4 shows the number of fatal accidents on each day. On Sundays it is the lowest because of the least work compared with other days. On Mondays it is fairly increased. It is supposed that the morale of the workers is not heightened and their minds are not adapted to work after Sunday's rest. On Tuesdays and Wednesdays it goes on well but the accidents in tend to happen toward the weekend but on Saturdays they fall slightly. These phenomena are supposed to relate to the physical exhaustion of workers, exhaustion accumulates through the daily work, so that their working morale become normal but they are getting exhausted physically. We do not have exact data that how many parties are on duty on Saturdays. But we can presume that the rate of the accidents is probably higher than other days, the number is decreased though.

Then we examine the accidents of each month (Chart-5). With regard to the cycle of maintenance work in our company in April, the first month of fiscal year, the work is not much, in May it raises and in June and July falls gradually. Between October and November the work increases and from January to March, before the end of fiscal year, tends to increase. We assume that the number of the accident in each month related to the number of contract work and amounts of actual work, that is, the later increases and the former goes up as well. A probability of the accident is supposed to be almost the same through the year.

Factors of the accidents are different from each other in the different length of period such as for a week, a month or a year. Generally, the factor of the accidents is affected by a physical condition of worker in a weekly cycle, by an amount of work in a monthly one and by a company or union's stance and its campaign to prevent the accident in a yearly one.

After the safety campaigns since 1989 by both the management and union and after the International Railway Safety Conference which appealed that the whole employees should prevent the accident in 1990, we had only one fatal accident for the following year, 1991/2. We recognized that our motto or concept which established in the Conference was right.

(2) Examination of two cases

If the train and workers do not meet at the same time and in the same place, the running-over accident will not occur. So the roll of a train-watcher is still important. The safety of workers mostly depends on him.

In case A, first, all members from the site manager to his workers convinced that the train would never come. The train-watcher must always pay his attention to trains but it is difficult to continue to watch in such a dark night. Second, the team had a feeling that they wanted to finish up whole the work. So, they began the unscheduled work. It is supposed to be a background factor of the accident. Finally, the site manager knew the site and timetable so well that he had a conviction that there was no train at that time.

The main factor in case B accident is a wrong timetable. The another factor is that the team directed by the foreman started the work in spite of the site manager's message. It is unpleasant for the workers to work at night, so it is natural to think that they wanted to finish the work and go home to rest.

The accident happens only when all factors were completed. In other words, if we remove an element we can prevent it. We can suppose in case A, (a) if they did not work on the place which was not planned, (b) if the express did not delay, or (c) the train-watcher did pay attention to the train. In case B; (a) if the train timetable was not written wrongly, (b) if the workers began to work on schedule, or (c) the train-watcher watched the train ... If we had remove one element we could have prevented the accident.

Certainly, to avoid wrong understanding, providing correct and timely information to the workers on site is very important. But I believe there is another point in preventing the same kind of accidents.

There are many running-over accidents caused by an "absorption mistake" in the track maintenance work. The workers who absorb in their work likely can't recognize approaching trains and are hit by them. However, the cause of the two cases that I mentioned above is obviously different from "absorption mistake." The victims of the two accidents must have no experience on running-over accident in their some decades of occupational career. So, they might have thought, "I will never be involved in the accident." With this groundless conviction they worked against the rules or plans and caused accidents.

So, it is essential to know why workers didn't comply with rules or with plans. Now we must consider what they felt and thought on the scene. In the Mito station accident, the motive for completing the work in a short time made the site manager commence unscheduled work. In the Kashimadai accident, the foreman wanted to finish the job earlier and directed workers to start. The site manager behaved representing the interest of the co-operation company and foreman behaved representing the workers' desire.

A railway company makes work plan considering safety but co-operation companies or workers see the work from their own view point. We, the workers' union, must make a further investigation through frank and eager discussion among the workers. This study will lead us to review the actual system of track maintenance work itself.

5 Proposal

(1) Train-watcher and new machine

We have to say that eventually a train-watcher is not a final stopper of the accident. When he is a skillful and experienced worker he sometimes joins the work and, as a result, he does not concentrate on his duty. After the two accidents JR East made the qualification of train-watcher more strict.

At the present, to keep safety of construction work still owes to the train watcher. He can concentrate his work when there is certain density of the traffic but when there is very low density he might lose his tension. He is a human and he cannot pay attention all the time. We admit the importance of the roll of train-watcher but we also believe the necessity of machine, such as a train approach warning system, to supplement the failure of train-watcher. Still, the machine is not all. We cannot stop all trains during the maintenance work, so we have to reply on a train-watcher who watch the train, let the workers escape safely and send a signal to a train driver.

Fortunately, we are researching a wireless train approach warning system aiming at practical use and we believe it will be introduced in a future.

(2) Communication

We will never succeed in preventing accidents by "top-down" order system, that is, if the top management plans the safety measures without considering the ideas or opinions in the work place, they would not be effective and put in practice. JR East continues the "Challenge Safety Campaign" aiming at drawing out the idea from employees in the work place. Quality Control (QC) activity is popular among Japanese companies. Our management takes the method of QC activity in their campaign.

We are convinced that the management's attitude toward the employees is important and we also believe that the frequent meetings among people who concerned the safety measures are essential. For example, between JR East and the co-operation companies or sub-contract companies, among site managers, foremen, their workers and supervisors, employees in JR East, the meeting should be free and frank to communicate each other. On a basis of communication in the work place we should create an atmosphere and relationship that if someone breaks the rule the other one can point out of its risk without hesitation.

Through these activities we will learn the importance of keeping safety and our lives. We might emphasize them repeatedly and we believe that we will create a kind of culture of safety among our union members.

(3) Working condition and management

It is reasonable to think that workers would like to finish their work earlier and go home earlier to take a rest at night. A site manager always warns risk of the accident but his workers do not always listen to him, so they have to work under the risk of accidents. In this sense, an accident is inevitable.

First we insist that the improvement of working condition is indispensable so as not to cause the accident. We will have to review the present wage system and working shift. "Daily wage salary" should be changed. Night work continued from day time with a little catnap also should be improved.

Second, we demand that construction work should be ordered constantly through the year, because haste work, especially in a final two or three months of the fiscal year, causes accidents. We also ask a rational budget system and working plans that the workers can work steadily.

Third, we request that on the one hand JR East should help the co-operation companies financially and it should revise unfair-relationship like "strong purchaser and weak contractor." On the other hand, the co-operation and sub-contract companies should make efforts to be independent from JR East, especially, in the safety and technological education.

Finally, JR East should not demand them strict regulation and massive burden, such as, on method of the engineering, number of workers or strict safety measures. In other words, the co-operation companies should accomplish their contract by their own ways being independent from JR East.

They cannot run the co-operation company without considering benefits and they cannot consider the safety measures without healthy management.

(4) Working circumstances

We propose that JR East should take the idea that all the train should be stopped during the maintenance work if it is impossible to have a sufficient interval of trains, though this method has already be introduced in Shinkansen line. If we introduce this we have to cancel trains or change the operation from double-track system to single one. If the workers work in a day time, they are not tired compared with working at night. Recently, the company put this method into practice as an experiment in some districts because JREU proposed that. In four-track line of Tokyo area, the method has been introduced by using two-tracks. We call it "annexation driving system". Although it is easy to put into practice in four-track line but different in two-track one because we need the improvement of equipment and facilities.

We have to ask understanding to passengers in order that we introduce this method and cancel trains. We also have to point out that keeping safety costs not only money but also passengers' inconvenience. We have a saying in Japan; "A customer is a God." But we believe it is wrong. We must say; "Both customers and railway workers are human beings." We have to ask our customers to share the cost to secure the safety.

In Shinkansen line there is not daytime maintenance work and regular inspection at all. They work at night between the final and the first train since Shinkansen started in 1964. While the line is operating, the operation controller controls the traffic but while the maintenance workers are working the controller in the maintenance department controls the traffic. As a result, the running-over accident hardly happened in Shinkansen line. Although, they have five hours at night in Shinkansen but only two to three in the other lines, so that, the workers begin the preparation work before trains stopped. We suggest strongly that Shinkansen system should be introduced to the other lines otherwise we cannot avoid running-over accidents on the track in service.

6 Conclusion

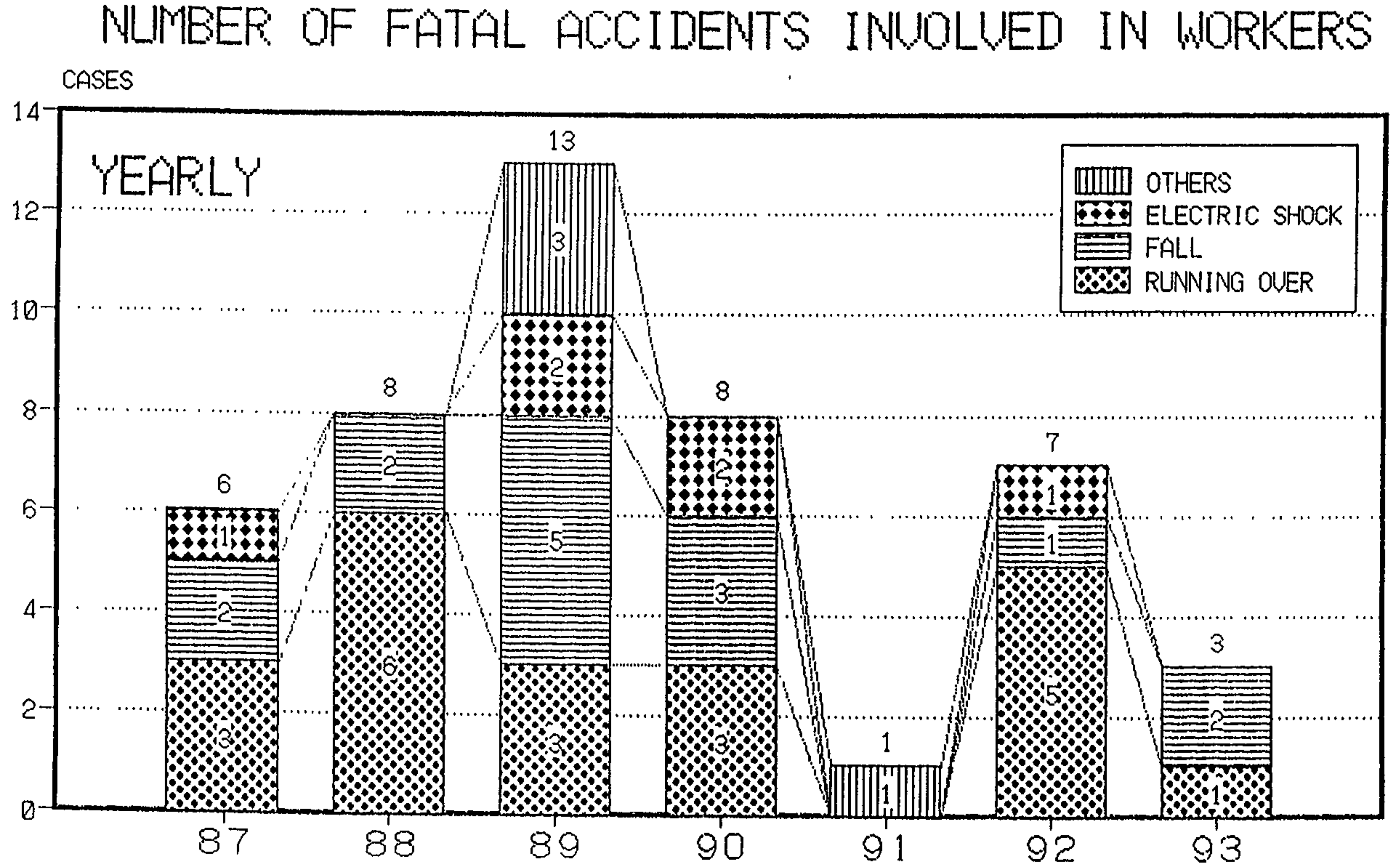
When the accident in Mito station happened, "Kokuro", Japan National Railway Workers Union which once was the biggest union in the JNR era, merely blamed management's attitude in safety measures but there is no point in saying so without alternative plan. The management in some other JR companies says in public that trade unions do not need to think about the safety issue. This idea is the same of "Kokuro". JREU believes that if we do not tackle the safety issue as our own problem, we cannot find any solution. We, therefore, discuss it seriously with the management.

On the one hand we know the importance of securing the safety but on the other hand, we did not notice and evaded the responsibility of the accidents which involved in contractors' workers. The aim of trade union is to protect our lives and rights, and promote our social position. The value of life is the same and we have recognized that it is also our aim to secure the lives of workers in the co-operation and subcontract companies.

In conclusion, we believe that the co-operation of the union and management is indispensable with regard to the safety issue. The stances of the union and management are different from each other but keeping safety is a common problem between us. We believe that we could not co-operate without respecting each other. We developed this labour-management relationship overcoming the suspicion for years and we will maintain and promote it.

Our wisdom and effort might be limited and it might be difficult to prevent running-over accidents, but we believe that we can reduce it.

Fig-2



NUMBER OF FATAL ACCIDENTS INVOLVED IN WORKERS
CASES
YEARLY
OTHERS
ELECTRIC SHOCK
FALL
RUNNING OVER
0
2
4
6
8
10
12
14
87
88
89
90
91
92
93
6
8
13
8
1
7
3

Fig-1

NUMBER OF RAILWAY ACCIDENTS

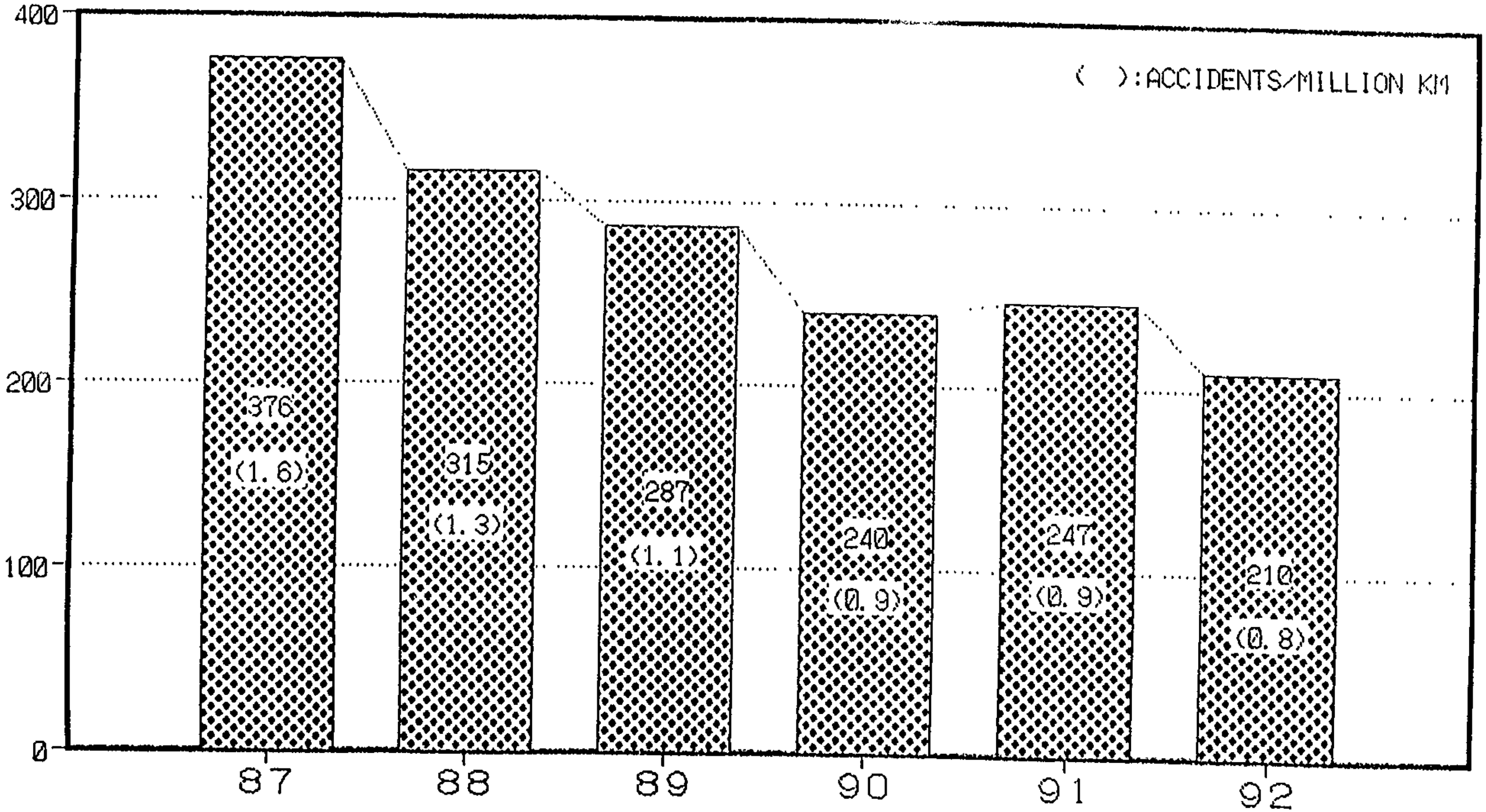
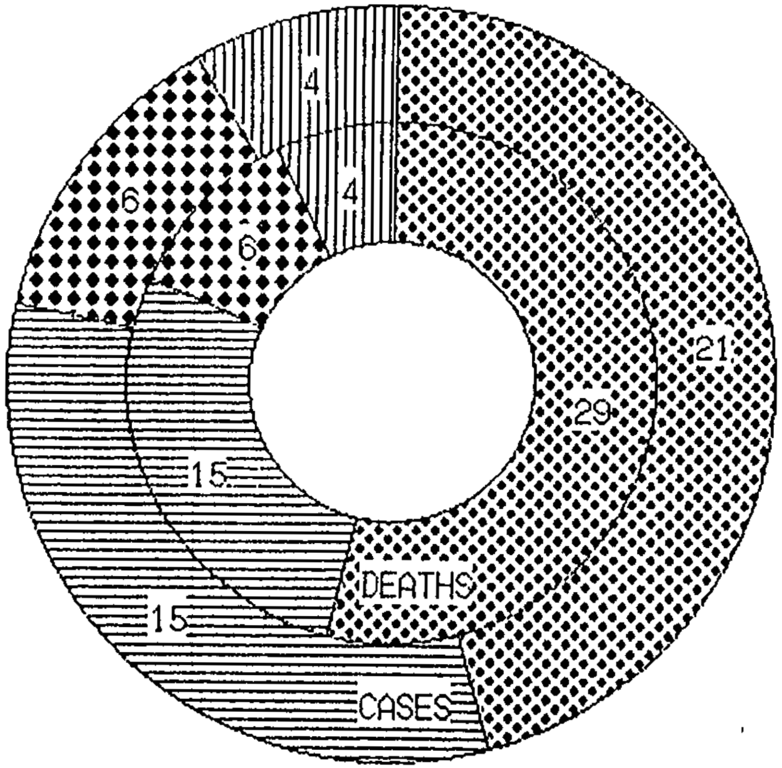


Fig-3

FATAL ACCIDENTS



	CASES		DEATHS	
RUNNING OVER	45.7%	21	53.7%	29
FALL	32.6%	15	27.8%	15
ELECTRIC SHOCK	13.0%	6	11.1%	6
OTHERS	8.7%	4	7.4%	4
合 計	100.0%	46	100.0%	54

Fig-4

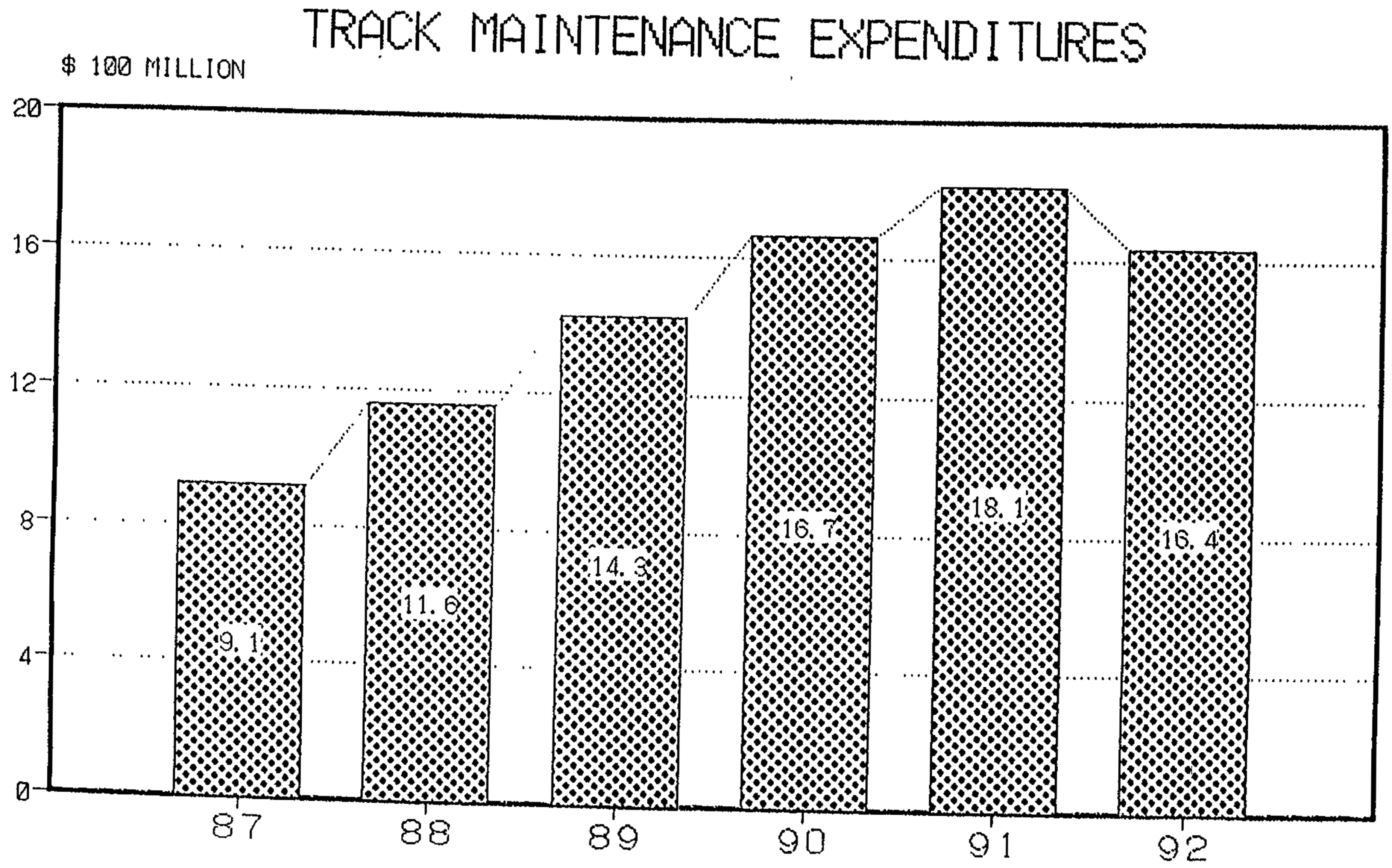

TRACK MAINTENANCE EXPENDITURES
$ 100 MILLION
20
16
12
8
4
0
9.1
11.6
14.3
16.7
18.1
16.4
87
88
89
90
91
92

Fig-5

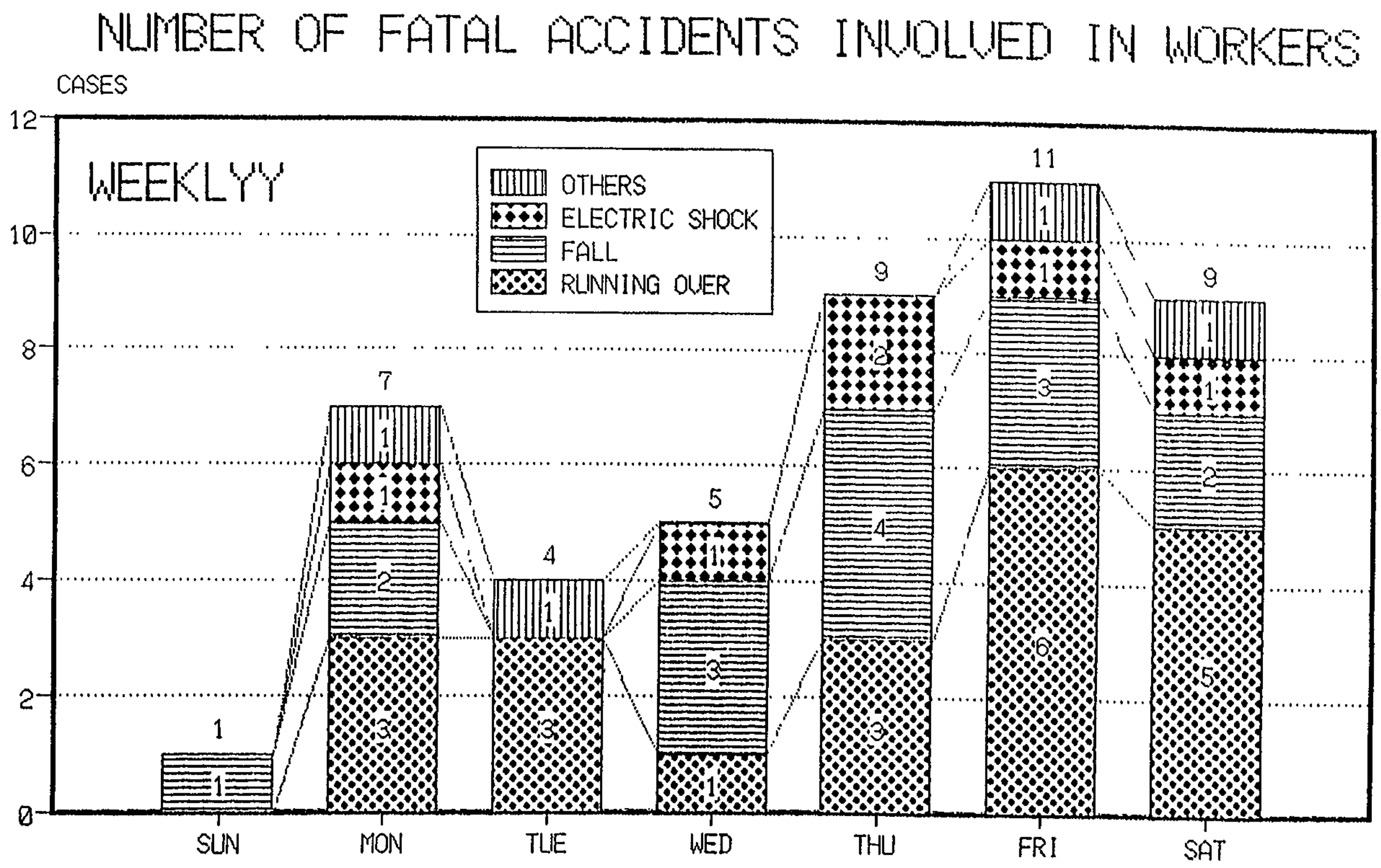
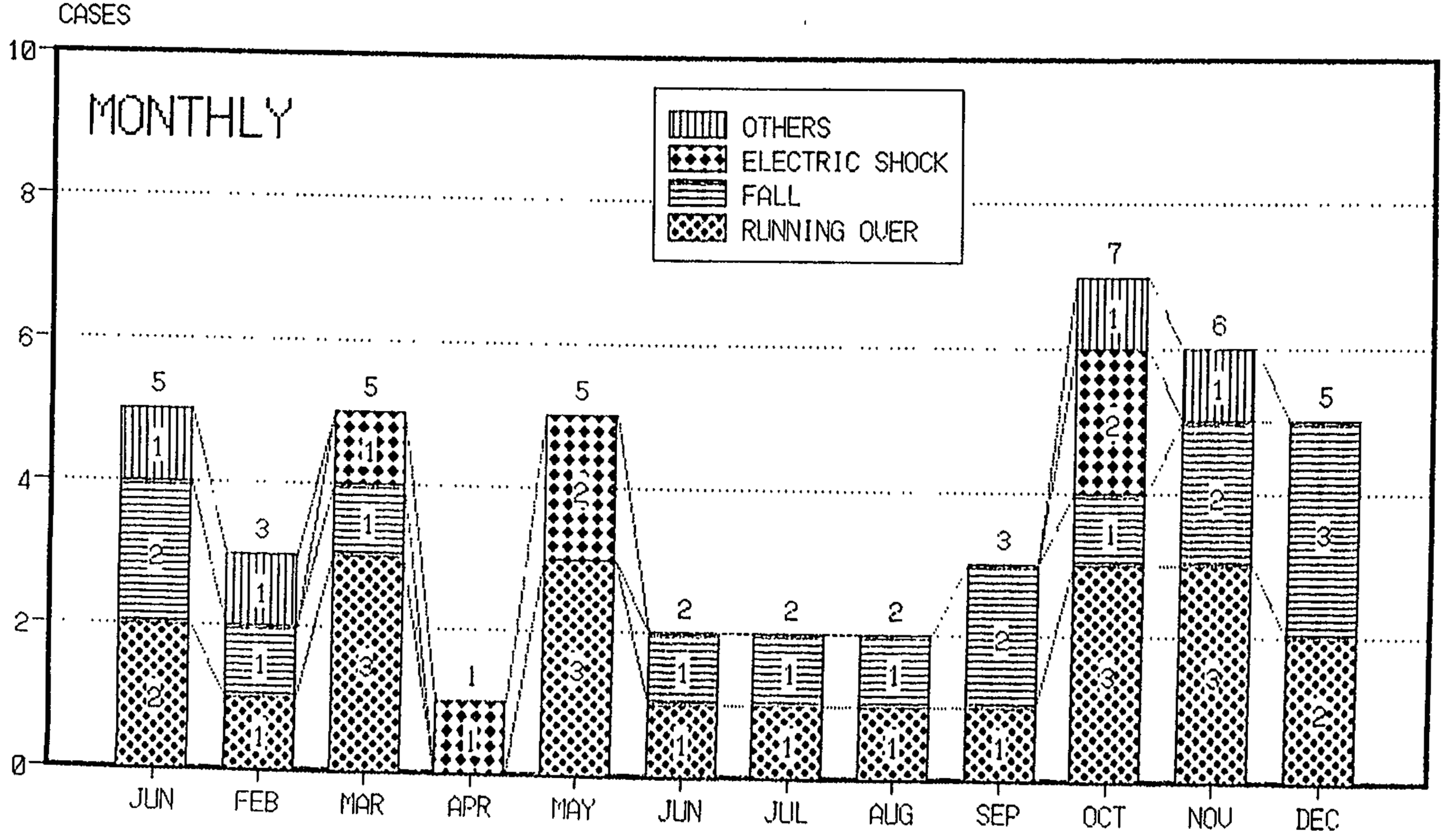

NUMBER OF FATAL ACCIDENTS INVOLVED IN WORKERS
CASES
WEEKLYY
OTHERS
ELECTRIC SHOCK
FALL
RUNNING OVER
0
2
4
6
8
10
12
SUN
MON
TUE
WED
THU
FRI
SAT
1
7
4
5
9
11
9

Fig-6

NUMBER OF FATAL ACCIDENTS INVOLVED IN WORKERS



International Rail Safety Conference

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9322

Michael Siebert

Use of the international safety rating system on a railway

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

USE OF THE INTERNATIONAL SAFETY RATING SYSTEM ON A RAILWAY

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British Railways Board

USE OF THE INTERNATIONAL SAFETY RATING SYSTEM ON A RAILWAY

Introduction

To explain why BR chose the International Safety Rating system requires us to look at the background of BR up to that time. BR was formed in 1948 as an amalgamation of four private railway companies even though they had by government intervention already taken on some aspects of a nationalised railway. At that time BR employed approximately 500,000 staff.

BR's safety management at that time consisted largely of ensuring the safety of the passage of trains and the safety of staff while being of concern to local managers was not seen as being one the major issues of the day. The number of staff fatalities did decline but chiefly as a result of the decrease in staff numbers and the cessation of some of the high risk tasks.

BR continued to change, particularly to decrease in size, restructuring its management organisation on a frequent basis. This led to difficulties in management control of the workforce since neither the managers nor the individual members of the workforce were necessarily entirely sure what their job was or to whom they reported. Many were displaced and therefore had no great commitment to the task they were undertaking. The major change which began to appear was the restructuring of BR into a customer focussed organisation, the beginning of the formation of the Business Units.

The first major influence on BR's safety philosophy in recent years was the fire which happened at Kings Cross Underground Station. Whilst this was strictly a matter for London Underground and indeed the Fennell report was directed in terms of railways directly at the Underground, the BR Board recognised that there were significant issues which were just as relevant to themselves as they were to London Underground. They therefore publicly accepted those relevant recommendations of the Fennell Inquiry and in 1988 appointed Maurice Holmes, then Director of Operations, as its first Director, Safety. One of his roles was to look at the whole safety management systems within BR. Also in 1988 BR adopted a policy of total quality management throughout its organisation.

The processes that were being set up were interruped in every sense by the accident at Clapham Junction in December 1989 and the internal and external (Hidden) inquiries that followed. Again methods of managing safety came under scrutiny and BR was severely criticised for its existing systems. It had however already determined that it needed a system for auditing management processes for safety.

Director, Occupational Health & Safety set up a small working group to identify what audit systems were available for use in management systems. That working group recommended the use of the International Safety Rating System within BR. That policy was adopted through the internal management processes of BR and accepted by the BR Board. It decided that it would set up a team reporting at Group level which would carry out audit on behalf of BRB across the whole of the railway and it also decided to recruit the leader of that team from outside the railway.

Formation of Group Safety Audit

I was recruited in July 1990 to recommend to the Board the audit processes, frequencies and hence the size of the audit organisation which would be required to fulfil that role and then set up and lead that organisation.

An early task was to identify the objectives of the management safety audit process and they were listed as follows:

> To inform the BRB and its organisational units the extent to which policies, technical standards, operational standards and procedures are in place which -
> (a) protect customers and the general public
> (b) protect the health and safety and welfare of employees
> (c) meet wider industry best practice
> (d) meet the requirements of the BRB safety programme and safety plan

The total audit resource as well as auditing management processes and procedures using ISRS would also audit:

(a) the development of policies, standards and rules
(b) compliance with policies, standards and rules and
(c) the management of contractors.

In order to determine the size of the organisation it was necessary to determine how many audits would be carried out particularly using ISRS. Since BR was undergoing a significant reorganisation into the Business Unit/Profit Centre formation an estimate had to be made of just how many auditable units would result. The identification at that time was that there would about 124 auditable units and by an estimation of the time it would take for each audit plus the times to audit the other activities indicated above showed that an organisation of some 40 staff would be required. It was determined that there would be annual audits of each Business Unit and Profit Centre and for auditable units below Profit Centre level an audit would be carried out by the Group team about once in every 4 years. The need for audit teams at Business Units and Profit Centres was identified and their role would be to carry out audits below Profit Centre level on the other 3 years of a 4 year cycle. (Currently a total of 222 auditable units has been identified and a total throughout BR of 67 auditors have been appointed. This roughly equates to 1 auditor and 2000 staff.)

We identified at a very early stage that there were significant dangers in appointing permanent teams of auditors. They would very rapidly lose their identification with railway operations and stood in grave danger of becoming isolated, inward looking and over judgemental. As a result we determined that the staffing of this team would be from a small core who may well become permanent or at least rather longer term with the majority of the auditors joining the audit team, staying for about 2 years and then returning to their specialism within the railway. It was not foreseen at that time the nature of the management changes which are now upon us and will make that system more difficult to implement. The principle however is still in my view completely valid.

It was also necessary to set up an auditing process which did not lead the management team being audited to believe that they were simply being examined by some outside body against an arbitrary standard. The intention was to give to the manager a comprehensive report on his safety management systems but in such a way as to support his ability to improve management rather than simply criticise it. To this end a number of important decisions were made:

1. that the audit report would only be shown to both the audited manager and his immediate superior.

2. at the end of the audit he would get an immediate feedback and that the draft report would be discussed only with him until such time as both it and its recommendations had been agreed.

   In this way he would retain confidence that the process was to support him.

The only respect in which we have not been able to maintain this process is when the Chief Executive determined that he wished to receive copies of the audit reports on Profit Centres.

The process by which an audit is carried out is shown in the attached figure.

<u>AUDIT PLANNING PROCESS</u>

<u>Audit Plan</u>	Agreed 6-15 months prior with local manager
<u>Pre Audit Call</u>	Telephone reminder 10 weeks prior to audit.
<u>Pre Audit Meeting</u>	- 4 weeks prior to audit to plan and allocate audit elements within the team - Teach the purpose of Audit ie to motivate managers to improve safety management - Define the levels of management Leave a briefing pack to explain the process - Review the previous audit and measure progress - Seek appointment of an audit co-ordinator - Stress the need to prepare for the audit
<u>Opening Meeting</u>	First day of the audit: - Introduce the audit team - Reassure - the object is to help, not criticise - Confirm the audit plan in detail - Plan a closing meeting
<u>Audit</u>	Usually by 1 or 2 auditors, 1 week on site
<u>Closing Meeting</u>	On last day of audit: - Debrief the highlights. Identify areas for urgent attention - Praise progress made

<u>Report</u> Produce the report within 10 days and give auditee a draft copy

<u>Facilitation follow up</u>

- Visit the local manager 4 weeks after the audit
- Review the draft copy and sign off
- Gain commitment to an action plan produced by the local manager to implement the audit findings.

It will be noted that great efforts were made to ensure that the manager being audited was aware well in advance the dates of the audit and the questions that would be asked of him; indeed assistance would be given if necessary to ensure that he understood it. To this end a great deal of time was spent in producing a users' guide to ISRS for the railway as some of the phraseology was unfamilar to railway managers. It was also used to demonstrate to them that many of the day to day processes that they employed would be acceptable under the ISRS system and they would not be penalised because it was titled differently.

In order to cover the whole of the UK the safety audit organisation was split into 3 sections to cover the various parts of the UK. Two of the sections were in London and the 3rd was set up in Darlington, in north east of England 500Km north of London. They identifed with the various management units of the railway so that as far as possible the audit team leaders would set up a relationship with the managers of the units being audited. If for some reason auditors from one team took part in an audit in an area covered by a different team it would still be the identified team leader who would discuss the outcome with the manager. Again in this way we intended to develop a relationship between the auditors and those being audited.

<u>THE AUDIT SYSTEM</u>

The International Safety Rating System is a proprietary audit system where the questions are split into 20 Elements as follows:

1. Leadership and Administration
2. Management Training
3. Planned Inspections
4. Task Analysis and Procedures
5. Accident/Incident Investigation
6. Task Observations
7. Emergency Preparedness
8. Organisational Rules
9. Accident/Incident Analysis
10. Employee Training
11. Personal Protective Equipment
12. Health Control
13. Programme Evaluation System
14. Engineering Controls
15. Personal Communications
16. Group Meetings
17. General Promotion
18. Hiring and Placement
19. Purchasing Controls
20. Off-the-Job Safety

Audited management teams can select those activities where they wish to have their performance monitored but their score is always recorded as a percentage of the maximum possible from all 20 elements. They are also given feedback as to how effectively they have progressed in their chosen activities.

The answers obtained from management interviews are checked from documentary evidence and by sample interviews with employees. This is not designed to trap managers in a lie, but to confirm to them how effectively their activities are influencing their staff. The elements are designed to reinforce the fact that good safety comes from good management including:

planning
organising
leading
controlling

Audit Findings

The first audit took place during the late summer of 1991 as the team was being recruited. However this coincided with a major part of BR's reorganisation and the overall process was delayed some considerable time by Organising for Quality. As a result the full audit programme did not start until the summer of 1992. The early results were in absolute terms quite disappointing in that the average scores were in the order of 14 to 15% although some organisations scored more than 30%. We were somewhat reassured by a feedback from ILCI that the average of all first audits they had ever undertaken was of that same order, perhaps 1-2% higher, which we did not consider to be significantly different. This gave us some confidence both in our own management and in the processes we were using. As the number of audits built up it was clear that certain activities were coming out in the top of the recommendations time after time and the 10 most significant items during 1993 are shown in the attached figure. These are listed based on the frequency of the recommendations which were made specifically for the unit manager to address himself.

Following the audit, recommendations for action are made in each of the Elements visited. In addition the 10 or so most important recommendations (irrespective of Element) are brought forward for the personal attention of the senior manager. It is interesting to note that the order of frequency of recommendations has hardly changed. The top 5 have been recommendations on:

Emergency Planning	9.7%
Planned Inspections	9.5%
Personal Protective Equipment	8.7%
Accident/Incident Investigations	8.3%
Safety Policy	6.0%

(% is of all of the most important recommendations)

Critical Success Factors in Safety Management

Analysis of audits has indicated a number of featurers which improve safety performance and distinguish better audit performing organisations from others. They include:

1. COMMITMENT FROM SENIOR AND MIDDLE MANAGERS to enforcement of complaince with rules, procedures and safe working methods, consistently challenging non compliance to demonstrate that safe behaviour is a pre-requisite.

2. THE AVAILABILITY OF A WELL-QUALIFIED SAFETY PROFESSIONAL ON THE MANAGEMENT TEAM. We found this was a key factor driving the production of improved safety systems, as a catalyst for change and a focus for an effective safety communication effort.

3. A MANAGEMENT TEAM THAT WORKS IN HARMONY. Good leadership is essential, but a dominant character resistant to change often stifled necessary progress, either deliberately or by default, causing inaction on audit and safety plan/programme initiatives.

4. SAFETY OBJECTIVES FOR MANAGERS which are specific, measurable, achievable, realistic and trackable. Objectives need to be related to Safety Plan and Safety Programme needs.

5. OBJECTIVE SAFETY MANAGEMENT DECISION MAKING based on an analysis of risk and needs.

6. PRODUCING ACTION PLANS FOLLOWING AUDIT AND OTHER KEY SAFETY REPORTS to ensure improvements required happen and are clearly allocated to an individual to manage. Early evidence from nine second occasion audits in the 1993/94 programme indicates that lack of action plans are a factor in retarding progress within safety management.

7. SAFETY TRAINING - Above average management and supervisory training in safety management techniques.

8. MANAGEMENT ACCOUNTABILITY - Holding managers to account for their objectives, delegated safety performance targets and action plan delegations. Still too many managers set inadequate objectives which are then no systematically monitored to gauge the level of achievement. Accountability is vital to achievement and is often a key element governing management effort.

9. MONITORING CLARITY AND PENETRATION OF COMMUNICATIONS - Clearly communicating decisions, directives and policies from the top to the bottom of an organisation and monitoring achievement against defined measurable criteria.

10. SYSTEMS INTEGRATION - Having management systems that integrate from the top to the bottom of an organisation, ie one system, not two or three unrelated or poorly related onces.

11. EMPLOYEE INVOLVEMENT - Organisation that involve the workforce constructively as an input to decision making at all levels, and not just the management team.

Top 10 BR Safety Management Improvements Required, 1993

1. Emergency Planning - wider scope
2. Planned Inspections - systematic approach
3. Personal Protective Equipment - assessment of need, greater employee involvement in choice
4. Accident/Incident Investigations - system identifying human and management control failures
5. Health and Safety Policy - general improvements
6. Control of Hazardous Substances to Health - risk assessments
7. Group Meetings - monthly management safety briefing
8. Induction Training - Safety and Legislation training for managers
9. General Safety Rule (Base 650 Recommendations)
   - less prescriptive rules
   - identification of general principles for a safety system of work
10. Management Training

Basis - frequency of recommendations by element

42% of critical recommendations in 1 to 5
62% of critical recommendations in 1 to 10

This form of audit has been very new to BR and some managers still had difficulty in understanding the requirements of a good safety management system within their organisations. There is still a need within BR to recognise that the effective way of managing safety is to have a robust safety management system which starts by identifying objectives to be achieved, putting into place processes to achieve them, monitoring that achievement and then feeding that back into the identification process, a virtuous circle. In many cases we have found that where the objectives were not clearly identified there was no real process of feeding back to see how effectively they have been achieved.

There is a need to change both the attitudes and the behaviour of many managers and their staff. The cultural change that we are seeking and that audit is attempting to identify will rely upon strong management committed by their words and actions to compliance with safety systems, on a clear identification and communication of the goals and objectives of the organisation and a sharing of those goals by both management and the workforce by understanding the human and organisational factors that govern safety behaviour, particularly in areas of rules conformance. Finally it will be achieved by motivating others to change their behaviour through training, briefings and incentives. This will involve including safety performance in the management staff appraisal systems showing that BR is committed to improving its overall performance.

Relationships with other organisation

BR recognised that it could become totally inward looking even using an audit system like ISRS and it determined a need to exchange best practice with other users. To that extent it was one of the founder members of what is called the ISRS Users Group in the UK. This consisted of 10 or so of the major ISRS users including companies such as BP, PowerGen, Laporte Chemicals, ICI and others. We were able to compare methods of using ISRS and also to use the group as a focus for discussions with the International Loss Control Institute who are the owners of the ISRS audit system. This has been extremely valuable in understanding how BR's safety management compares with with others in the industry.

The future

BR is undergoing yet another major change and in April of next year will split into 2 separate organisations. Railtrack will control the track and infrastructure and have overall responsibility for safety of the running of the railway. BR will continue to exist as an operator of trains and a maintainer of the infrastructure under contract to Railtrack but it is intended that it will slowly sell off both the train operating companies through a franchise process and the infrastructure maintenance organisations. How will this affect the audit processes?

First of all Railtrack will not take responsibility for auditing all the players on the railway. Every organisation which is involved in the railway will be required to have its own safety management systems and its own audit processes to ensure it keeps to them. Railtrack will have a supervisory role in this but will of course, as a railway operator, have its own safety management system and own audit processes.

Railtrack will use ISRS within its own organisation. It will expect others to use an audit system and initially BR has indicated that it will continue to use ISRS but once parts of it pass into the private sector, it will be up to their management then to decide what system they will use. Railtrack will require that an adequate system is used in order to demonstrate that the organisation is managing safety adequately. BR will have over 100,000 staff to start with and will be a major user of ISRS.

Lessons learned

What would we do if we had to start from scratch again? I am satisfied that the processes we went through were broadly correct. The method by which we chose the audit system was sensible. The way in which we set about the audit processes, I believe, gave confidence to management in the way we were doing it. The only aspect that I would do differently if we started again was that I would set stronger requirement for the improvements that I would have expected to see from one audit to the next. Very deliberately we took the view that this was the issue that line management should resolve with our advice. If we went through this process again then I would be much more involved in setting targets and gaining the commitment of both the audited team and their managers into accepting and meeting the targets set. I would also seek to ensure that the significant recommendations of the audit were included in the local managers' personal objectives so that he would have a stake in meeting those recommendations.

Conclusions

BR spent a significant time in determining the correct audit system for its needs and ensuring that it set up the correct processes to introduce it. The use of the system has been valuable in assisting managers to set up and use management safety systems within BR. It has also been useful in highlighting to the BR Board those areas where its safety plan and its safety programme can be focussed to meets its aims and objectives.

MS300993
(JL-1/9)

International Rail Safety Conference

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9323

Russel Blinco

The evolution of safety and loss control in the Canadian passenger transportation industry

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

THE EVOLUTION OF SAFETY AND LOSS CONTROL IN THE CANADIAN PASSENGER RAIL TRANSPORTATION INDUSTRY

Russel BLINCO

*Health and Safety
Department Director
Via Rail Canada INC*

GOOD AFTERNOON LADIES AND GENTLEMEN:

It is indeed a pleasure for me to share with you today, a number of successes that VIA Rail Canada has experienced with its Safety and Health / Loss Control program over the past few years, while working with the International Safety Rating System (ISRS). However, before going any further, let me first tell you briefly how VIA Rail evolved as a national passenger rail service in Canada.

In January 1977, VIA was incorporated as a subsidiary of Canadian National Railway and was deemed to be a railway company on March 22nd of that same year, following an elusive attempt by both Canadian National and Canadian Pacific Railways, to jointly reduce inefficiencies and losses to **their** passenger rail services.

As was the case with Amtrak in the United States, it was a belief in Canada that a separate company, dedicated solely to passenger rail service, would serve the Canadian public better than railroads whose principal activities were the transportation of freight. VIA was made a Crown Corporation in March 1978 and began its operations in April, initially with the provision of Customer Services for all passenger rail operations.

Operating on both CN and CP trackage throughout Canada, (roughly 8,500 miles), VIA remained dependant on these two companies for the provision of train control, operating crews, equipment maintenance and a number of other ancillary services, including safety, which at that time, was primarily concerned with the safe operation of rolling stock (as opposed to occupational safety and health).

VIA's head office is located in Montreal, and being organized functionally, Branch Vice-Presidents are responsible for specific areas of the operation across the national network.

VIA is organized in eight (8) branches and two (2) corporate departments:

Branches

Transportation
Customer Services
Equipment Maintenance

Marketing

Human Resources and Administration
Planning and Finance

Legal Services
Public Affairs

Departments

Internal Audit
Corporate Secretariat

Decision making is centralized through a Management Committee at Headquarters. This executive committe ensures the effective coordination of operations, facilitates the management of VIA's assets and monitors Corporate performance.

The three (3) operational branches of the Corporation comprise:

Transportation - which is responsible for the safe and efficient movement of trains in compliance with all operating rules and regulations;

Customer Services - responsible for all guest interaction, thereby ensuring safety, comfort and quality service for the travelling public;

Equipment Maintenance - whose responsibility is to provide safe, clean, comfortable and reliable trains, that will arrive on time and at an acceptable cost.

NOTE - These 3 branches account for 84% of VIA's current 4,595 employees

By 1985, with the acquisition of stations throughout Canada and the construction of maintenance facilities in five (5) strategic locations: Vancouver, Winnipeg, Toronto, Montreal and Halifax, it became evident to VIA Management that the Corporation's infrastructure was badly in need of a Safety and Health program, tailored to the specific nature of VIA Rail Canada.

A Corporate Health and Safety Director was appointed in July of that same year, then reporting directly to the Executive Vice-President of Operations. Over time, however, and as the Corporation evolved, this reporting relationship changed; to the Senior Vice-President of Human Resources in 1987 and finally, reporting to the General Counsel, Legal Services, in August of 1990.

The establishment of VIA's **Safety Policy** and specific **mandate** for the Health and Safety department, were soon to follow.

The Corporation's safety philosophy is simple, but sound, based on the premise that safety is a management responsibility, while at the same time requiring that all employees work safely, as a condition of employment. VIA Rail is totally commited to its Safety and Health/ Loss Control program, and it is Corporate policy to take all appropriate measures to ensure the protection of its passengers, employees and the public in general, while travelling in railway equipment, or while on company property.

In support ot its **Safety policy**, the Health and Safety department has been mandated to develop, introduce and monitor policies, standards and programs, aimed at increasing passenger safety, protecting the health, safety and physical well-being of its employees, and protecting Corporate assets from accidental loss.

But for minor changes over time, these two (2) cornerstones of Corporate direction to VIA's Safety and Health/Loss Control Program, have remained untethered.

Although safety and health were the initial concerns, the broader concept of **Loss Control Management** was being envisioned. This was considered as being the most effective and systematic approach toward the reduction of risks and accidental loss to **people, equipment, material** and the **environment**, by exercising management control of the exposure to all sources, (ie. injury, illness, damage, security related incidents, liability, claims, etc.); through **risk elimination, risk reduction, risk avoidance**, or **risk acceptance.**

Basic and sound safety principles have been around now for a long time, in one form or another, and it was not VIA's intention to reinvent the wheel. Following extensive research of the marketplace, for a program that could be adapted to VIA's particular needs, it was decided in August of 1985, to affiliate with the International Loss Control Institute (ILCI), {now the Loss Control Management Society - since being purchased by Det Norske Veritas DNV a few years ago}, whose mission was, and still is: **"The development and dissemination of knowledge and safety, health and loss control; and encouragement of general interest and activity in these important fields throughout the world".**

Furthermore, VIA's Corporate values; ***quality, productivity*** and ***responsiveness***, melded in well with ILCI's basic philosophy, which promotes ***quality, productivity*** and ***safety***. Responsiveness to its employees, is one of the ways that VIA demonstrates senior management's dedication to a **safe** work environment.

One other important reason for choosing ILCI, was because of the excellent **auditing** tool this organization had to offer. The International Safety Rating System is a modern, state-of-the-art means of measuring the effectiveness of any organization's safety and health/loss control program. It is common knowledge today that "**those activities that cannot be measured, cannot be managed**". Without this yardstick, VIA would not have been able to accurately identify the strengths and weaknesses of its program activities, and consequently, would not know precisely where to place present and future efforts, to improve the overall results of its program.

That is precisely why VIA's Safety and Health/Loss Control Program is based on the **standards** of the International Safety Rating System. These internationally agreed upon standards were developed by the International Loss Control Institute, in Atlanta, Georgia, (of which VIA is a Corporate Member), and serve to determine **who** does **what** and **when,** within all the activities of the program.

Being generic in nature, these standards had to be tailored to fit into the railroad culture and accommodate VIA's specific needs. These standards are an important and integral part of the Corporte Safety and Health / Loss Control Reference Manual, which now guides management and employees alike on VIA's consistent approach of program development, implementation, measurement and control.

To enable the Corporation to effectively implement its program, all VIA safety professionals have been trained, qualified and licensed as **Accredited Safety Auditors** through the International Society of Accredited Safety Auditors Inc., an affiliate of ILCI/DNV. They also report directly to the Department Director at headquarters, to ensure their independence and autonomy, which facilitates corrective/remedial action, where and when required.

To ensure high quality measurement of all program activities throughout the system, baseline, recognition or follow-up audits are conducted annually by the Corporate Auditing team, of all eleven operational units within the organization:

Equipment Maintenance	(5)
Customer Services	(4)
Transportation	(2)

The auditor, or auditing team, will measure the degree of program compliance within each operational unit, against the ISRS criteria, using actual count, random sampling and professional judgment techniques. The auditor's conclusions will be derived from interviews with knowledgeable persons, record and documentation checks, verification interviews with all levels of site personnel and a physical conditions verification of the audited location.

Once the audit measurements have been completed, the results are recorded and scores are tabulated. This process will contribute to the overall rating of the safety program effectiveness. within any given operational unit being audited.

In the event audit results warrant official recognition, the entire audit exercise is forwarded to the International Loss Control Institute for verification and validation, by a Special Audit Review Committee. For recognition to be awarded, it is essential that all scores be substantiated by **submitted** written documentaion, that must meet the stringent letter and intent of the ISRS.

To date, all operational units in the Equipment Maintenance and Customer Services branches, (9 of the 11 auditable locations), have attained international recognition in both the **standard** and **advanced** programs.

To ensure the ongoing development and improvement of the Safety and Health/Loss Control Program, a **five year plan** has been established, following in-depth consultations with all operational units of the Corporation.

A **Master Audit Schedule** is struck at the beginning of every calendar year and followed through to completion. The audit results are communicated to local and headquarter's management, and based on the identified areas of inefficiencies, objectives and action plans for the ensuing year are established.

The safety professionals play an important role at this stage of the process. They provide the necessary guidance and coaching to the local management teams, as new elements of the program are being developed and implemented, and those already in place are being strengthened and refined. It is also critical that the approach be consistent and uniform across the entire system, since Accredited Safety Auditors from one location, are called upon to audit the program elements within operational departments in other parts of the country, to ensure that unbiased and objective results are obtained, thereby sustaining the credibility of the program.

Management training is also an important part of any Loss Control program and although VIA has been without a centralized training function to address this area over the past few years, a cost-effective **Practical Loss Control Leadership**, (home study course), is being promoted in all operational departments system-wide. Here again, the safety professionals play a major role as qualified facilitators, leading the groups through structured discussions to ensure that all topics are clearly understood and that the training is thorough enough to ensure a broad understanding of safety management activities.

You might ask, "what are the key elements that have contributed to the success of VIA Rail's Safety and Loss Control Program?"

I would have to say, that it is due in large part to the consistency of VIA's approach to program development and implementation, and the effectiveness of the tool that we are using to measure the quantity and quality of management control, namely the **ISRS.**

Furthermore, all safety professionals are trained and certified **Accredited Safety Auditors,** which ensures a consistent measurement of program performance system-wide.

There is also total and genuine buy-in by local management and employees alike. And one must not forget the total commitment, encouragement and support provided by the Executive and Senior Management of the Corporation; **without it, we would not be where we are today.**

The results of auditing to date, in all three (3) operational branches, have demonstrated that, inasfar as the ISRS is concerned, VIA is right up there among the leaders in industry today.

For example, the Winnipeg Maintenance Centre obtained an **Advanced Level Three Rating** in October 1992, placing them among the top 10 percent of auditable sites in North America, which had submitted audit reports to ILCI for verification and validation. (only 41 out of 523 organizations were awarded **3 gold stars** in 1992). It is also to be noted that VIA is the first railway in North America to have received this level of recognition from the International Loss Control Institute.

The highest possible safety rating awarded by ILCI is Advanced Level Five (i.e. 5 gold stars). In 1992, only 3 organizations in North America were awarded an Advanced Level Four rating. None received 5 gold stars that year.

We intend to maintain this momentum and direction and according to our five-year plan, it is anticipated that by the end of 1995, **all eleven** operational units within VIA, will have reached the **advanced level rating** status, something that management and employees alike can be very proud of.

In 1989, VIA established its base year for accident/injury statistical comparisons. Reviewing the breakdown of frequency, severity and injury index rates since that year, it can be readily seen that the Equipment Maintenance Branch, where the risks of accidental loss are the highest, and where the Corporation had placed the major thrust of its Safety and Loss Control Program from the outset, improved their safety performance by over **63%**.

It was also observed that the number of accidents and lost work days had decreased by more than **60%** over that same period.

The Toronto Maintenance Centre, (VIA's largest - 374 employees), and the Halifax Maintenance Centre, were both successful in working over 200,000 manhours without a lost time accident in 1992.

Already this year, at the end of the second quarter, (June year-to-date), significant improvements in safety performance have again been realized, when compared to the same period of the previous year:

Customer Services	-	58% improvement
Equipment Maintenance	-	54% improvement
Transportation	-	40% improvement
and the overall system	-	50% improvement

We realize that measurement of injury experience is not the only true indicator of an effective safety program, and we are at present, more excited about the accomplishments stemming from the ISRS audits. However, there is definitely a correlation between both

proactive and **reactive** measurements, and these bottom-line results are a clear indication that VIA's Safety and Health/Loss Control Program is indeed on track, and heading in the right direction.

VIA has come a long way in the last five years. The past is behind us and high-speed rail may be in our future. As safety professionals in the rail transportation industry, we are being challenged to provide the best possible advice to management, and to develop specific, measurable, and attainable objectives, that will ensure a work environment free from accidental loss, and at the most optimum cost.

Thank you.

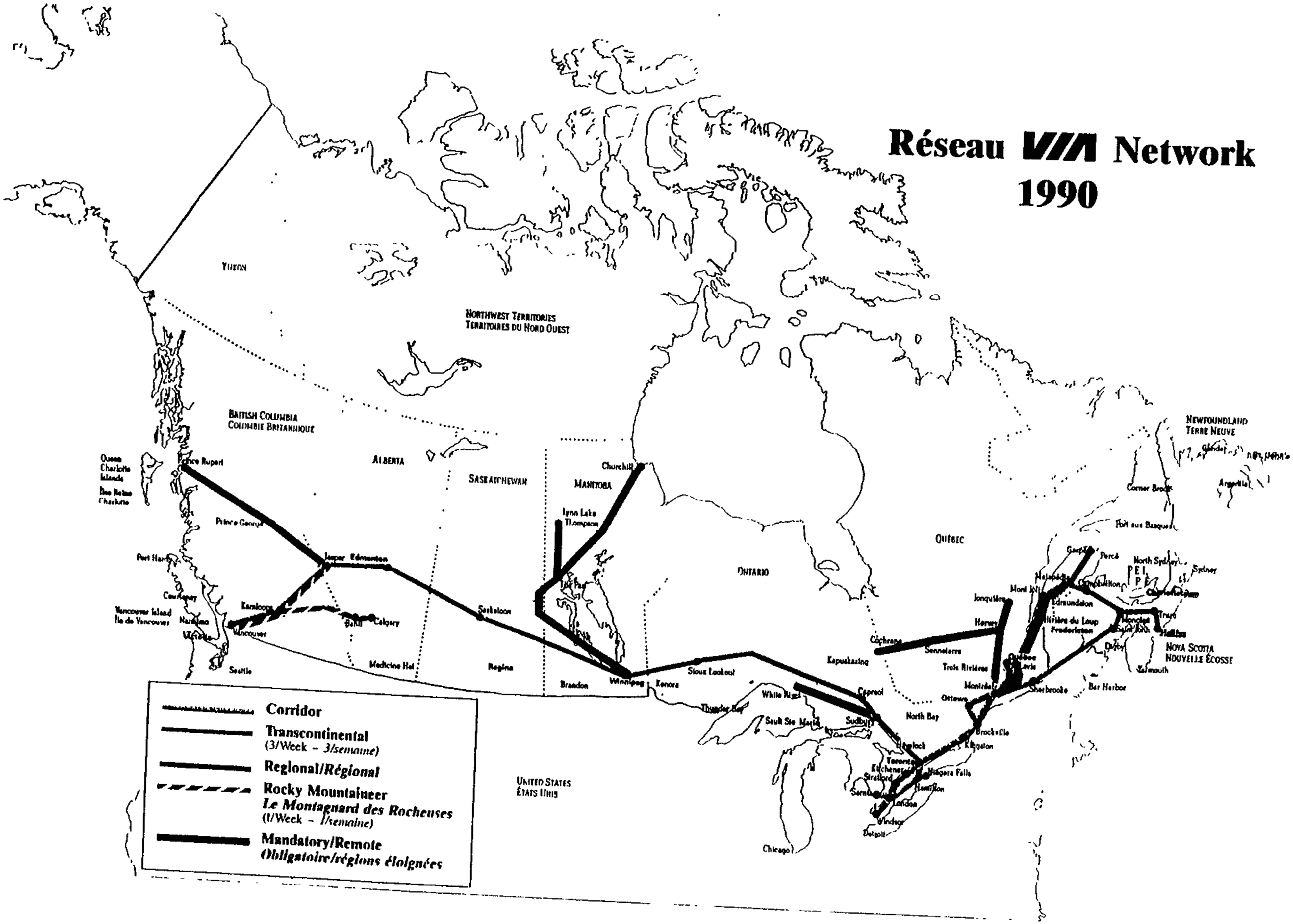
VIA Rail Canada

VIA's LRC (Light Rapid Comfortable) train leaves Toronto.

SAFETY AND HEALTH

LOSS CONTROL PROGRAM

Réseau VIA Network 1990



VIA 0379 8

VIA RAIL CANADA INC.

AVERAGE NUMBER OF EMPLOYEES

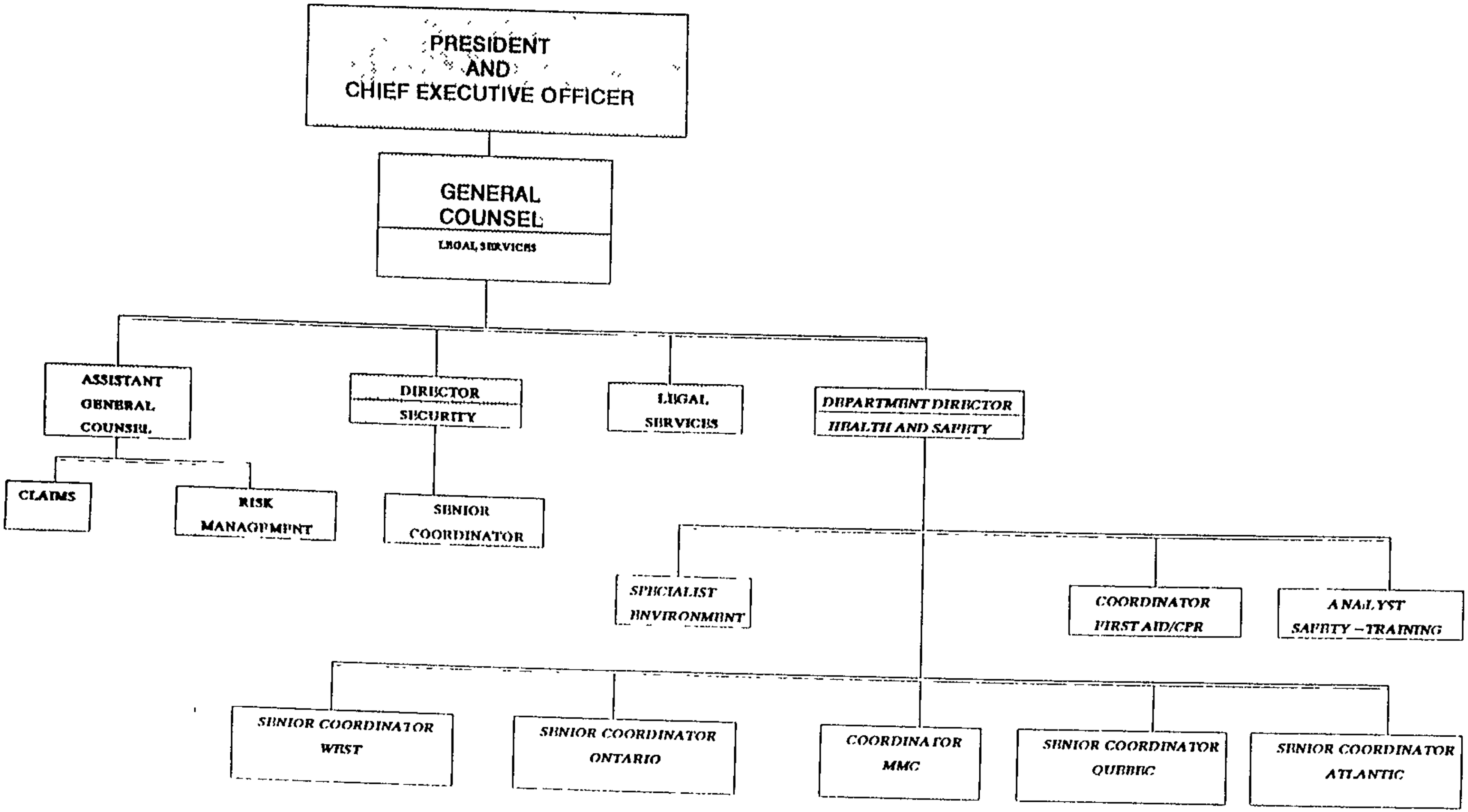
1985	1986	1987	1988	1989	1990	1991	1992	1993 (AUG.
4,178	5,370	5,726	6,873	6,594	4,663	4,477	4,494	4,595

↑ 64.5 %

↓ 32.15 %

↓ 33.14 %

LEGAL BRANCH – ORGANIZATIONAL CHART



Revised 93 02 03

VIA Rail Canada

Safety Policy

It is VIA Rail Canada policy to take all appropriate measures to ensure the protection of its passengers, employees and the public in general while travelling in railway equipment or while on company property. In following this policy, the Corporation will comply with all existing laws and take such other action deemed necessary in light of particular circumstances.

To this end, it is Corporate policy to sustain a continuing program designed to promote health and safety through the education of all employees and to cooperate with organizations and associations devoted to safety research and education.

Safety shall be regarded by all managers and employees as a prime consideration in the successful performance of their duties. Management is specifically responsible for the development and implementation of safe practices and procedures.

Managers at all levels will continually monitor situations to identify unsafe conditions, health hazards and equipment or mechanical defects that may exist so as to provide prompt and adequate corrective action. Accident prevention and the general level of safety will be one of the criteria used in assessing supervisory efficiency and ability.

Employees have the responsibility to perform their duties in a manner that will not jeopardize the safety of customers or adversely affect their health, safety or physical well-being or that of their fellow workers. Reasonable precaution is also expected from each employee to protect the property and equipment of the Corporation and that under its care.

The Corporation firmly believes that health and safety in the workplace can only be achieved through total commitment on the part of management and employees alike. It is therefore VIA policy to establish well organized joint health and safety committees where required throughout the system that will also conform to the spirit and intent of Part IV of the Canada Labour Code. This applied philosophy of sharing safety responsibilities will further the foregoing objectives and contribute to the enhancement of a safer work environment.

Chairman of the Board
March 31, 1986

Ligne de conduite en matière de sécurité

En matière de sécurité, la Société VIA Rail Canada a adopté une ligne de conduite très stricte, à savoir : prendre toutes les mesures voulues pour assurer la protection de ses voyageurs, de ses employés et du public en général qu'ils soient dans ses trains ou sur sa propriété. En suivant cette ligne de conduite, la Société se conformera aux exigences de la loi et prendra les dispositions jugées nécessaires à la lumière de circonstances particulières.

À cette fin, la Société s'est engagée à poursuivre un programme destiné à promouvoir l'hygiène et la sécurité, tant par la formation des employés que par la collaboration avec les associations et organismes voués à la recherche et à l'éducation en matière de sécurité.

Les gestionnaires et employés devront considérer la sécurité comme un élément essentiel à la bonne exécution de leurs tâches. Cependant, c'est à la direction qu'incombe la responsabilité spécifique de l'élaboration et de l'application [illegible] méthodes de travail.

Les gestionnaires, à tous les échelons de la hiérarchie, s'attacheront à exercer un contrôle continu des situations afin d'identifier toute condition dangereuse ou tout risque à la santé, de déceler toute défectuosité mécanique du matériel et de prendre rapidement les mesures correctives qui s'imposent. Prévenir les accidents et [illegible] en bon état de service quant à la sécurité seront parmi les critères retenus lors de l'évaluation du rendement et de la compétence des cadres.

Les employés ont la responsabilité d'exécuter leurs tâches de manière à ne pas mettre en danger leur propre santé, sécurité et bien-être physique ou ceux de leurs clients et collègues. De plus, chaque employé doit prendre les précautions nécessaires afin d'assurer la protection des biens et équipements qui appartiennent à VIA ou qui lui sont confiés.

La Société croit fermement que la sécurité au travail est réalisable en autant qu'il existe un engagement total et commun de la part de la direction et des employés. Dans cette optique, VIA s'est engagée à former des comités paritaires de santé et sécurité bien structurés dans tout le réseau, conformément à l'esprit et à la lettre de la partie IV du Code canadien du travail. Cette philosophie du partage des responsabilités en matière de santé et de sécurité permettra d'atteindre progressivement les objectifs ci-dessus et de créer un milieu de travail comportant un minimum de risques.

Président du Conseil d'administration
31 mars 1986

VIA Rail Canada

Safety Policy

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Chairman of the Board
March 31, 1986

PRACTICAL LOSS CONTROL LEADERSHIP

1. The Modern Evolution of Management
2. The Causes and Effects of Loss
3. Management Control of Loss
4. Accident/Incident Investigation
5. Incident Recall and Accident Imaging
6. Planned Inspections
7. Job/Task Analysis and Procedures
8. Planned Job/Task Observation
9. Group Meetings
10. Personal Communications
11. Employee Training
12. Job Pride Development
13. Problem Solving
14. Managing the Troubled Employee
15. Property Damage and Waste Control
16. Occupational Health
17. Fire Loss Control
18. Off-the-Job Safety and Family Loss Control
19. Special Problem Solutions

KEY ELEMENTS TO VIA SUCCESS

- PROGRAM CONSISTENCY
- EFFECTIVE AUDITING TOOL (ISRS)
- SAFETY PROFESSIONALS (ASA)
- BUY-IN / OWNERSHIP
  (EMPLOYEES AND MANAGEMENT)
- COMMITMENT AND SUPPORT
  (EXECUTIVE MANAGEMENT)

THE INTERNATIONAL SAFETY RATING

AWARDED TO

VIA Rail Canada Inc.
Winnipeg Maintenance Centre

FOR ACHIEVEMENT IN THE
INTERNATIONAL SAFETY RATING SYSTEM
ADVANCED PROGRAM

October 30, 1992
AUDIT DATE

INTERNATIONAL LOSS CONTROL INSTITUTE ATLANTA, GA.

AUTHORIZED SIGNATURE

Safety Award of Merit

Presented to the employees of the

Toronto Maintenance Centre

for having successfully worked 200,000 manhours
without a lost time accident

30 May 1992 to 28 August 1992

Congratulations

VIA Rail Canada Inc.

R.E. Lawless

R.E. Lawless
President and Chief
Executive Officer

AUDIT COMPARISONS
12 ELEMENTS
(1991–1992)

	ELEMENTS	PTS AWARDED JULY 1991	PTS AWARDED OCTOBER 1992	% IMPROVEMENT
1.	Leadership and Administration	735	921.0	25.3
2.	Management Training	239	368.0	53.9
3.	Planned Inspections	330	502.0	52.1
4.	Task Analysis and Procedures	x	x	x
5.	Accident/Incident Investigations	434	474.0	9.2
6.	Task Observation	x	x	x
7.	Emergency Preparedness	397	462.5	17.0
8.	Organizational Rules	165	256.0	55.2
9.	Accident/Incident Analysis	65 *	205.0	215.3
10.	Employee Training	301	371.0	23.2
11.	Personal Protective Equipement	315	390.0	23.8
12.	Health Control	242	368.0	52.0
13.	Program Evaluation System	x	x	x
14.	Engineering Controls	x	x	x
15.	Personal Communication	x	260.0	new
16.	Group Meetings	284	326.0	14.7
17.	General Promotion	x	236.0	new
18.	Hiring and Placement	310	313.5	1.1
19.	Puchasing Controls	163	215.0	31.9
20.	Off–the–Job Safety	x	x	x
TOTAL		3980	5668	
		3915 **	4969	26.9

* Not included in final score in 1991 (12 elements only required)

** 1991–92 comparison of 12 elements only

INTERNATIONAL SAFETY RATING

Summary Scoresheet

Audit of: Winnipeg Maintenance Centre
569 Brandon Avenue
Winnipeg, Manitoba
Canada R3L 0T7

Date of Audit: October 26–30, 1992

Audited by: Russ Blinco – ASA # 283
Jeff Erb – ASA # 517

Summary of Ratings

	Element	Points Possible	Points Awarded	Percentage
1.	Leadership and Administration	1170	921.0	78.7%
2.	Management Training	700	368.0	52.6%
3.	Planned Inspections	760	502.0	66.0%
4.	Task Analysis and Procedures	505		0.0%
5.	Accident/Incident Investigations	680	474.0	69.7%
6.	Task Observation	330		0.0%
7.	Emergency Preparedness	770	462.5	60.0%
8.	Organizational Rules	515	256.0	49.7%
9.	Accident/Incident Analysis	455	205.0	45.0%
10.	Employee Training	675	371.0	55.0%
11.	Personal Protective Equipment	450	390.0	86.7%
12.	Health Control	645	368.0	57.0%
13.	Program Evaluation System	430		0.0%
14.	Engineering Controls	510		0.0%
15.	Personal Communication	450	260.0	57.8%
16.	Group Meetings	400	326.0	81.5%
17.	General Promotion	355	236.0	66.5%
18.	Hiring and Placement	350	313.5	89.6%
19.	Purchasing Controls	400	215.0	53.8%
20.	Off–the Job Safety	250		0.0%
	TOTAL POSSIBLE POINTS	10800	5668	52.5%
	Total Possible Points for Elements Evaluated	8775	5668	64.6%

Based on the International Safety Rating System's conditions Guide for Inspections, or its equivalent, and as substantiated by audits and supporting records, what is the compliance with workplace standards within the organization? 95%
(See Physical Consitions Guide for Inspection Booklet.)

Signature ____________________

SAFETY PERFORMANCE

EQUIPMENT MAINTENANCE

1989		1992		IMPROVEMENT	
NUMBER OF DISABLING ACCIDENTS	NUMBER OF DAYS LOST	NUMBER OF DISABLING ACCIDENTS	NUMBER OF DAYS LOST	DISABLING ACCIDENTS	DAYS LOST
345	7808	122	2402	64.6 %	69.2 %

1989			1992			IMPROVEMENT
FREQUENCY	SEVERITY	INJURY INDEX	FREQUENCY	SEVERITY	INJURY INDEX	
16.3	367.9	6.0	10.6	208.0	2.2	63.3 %

FREQUENCY / FRÉQUENCE

$$\frac{\text{\# OF DISABLING ACCIDENTS (\# D'ACCIDENTS INVALIDANTS)} \times 200{,}000}{\text{ESTIMATED HOURS WORKED (HEURES TRAVAILLÉES ESTIMÉES)}}$$

SEVERITY / GRAVITÉ

$$\frac{\text{\# OF DAYS LOST (\# DE JOURS PERDUS)} \times 200{,}000}{\text{ESTIMATED HOURS WORKED (HEURES TRAVAILLÉES ESTIMÉES)}}$$

INDEX / INDICE

$$\frac{\text{FREQUENCY (FRÉQUENCE)} \times \text{SEVERITY (GRAVITÉ)}}{1{,}000}$$

ILCI
International Loss Control Institute

4546 Atlanta Highway
P.O. Box 1898
Loganville, Georgia 30249

THE LOSS CONTROL LEADER

Committed to the Success of Your Loss Control Management Program — 1992 Spring Issue

Inside:

Benefits of Order

Good housekeeping increases productivity, decreases costs

. 2

Tioxide (Malaysia)

Setting the safety standard in Malaysia's rocketing manufacturing industry

. 3

Great Lakes Bulk Carriers

An Ontario ship management company's push for seaworthy safety

. 6

ASA Corner

ASA Licensing Requirements

. 7

VIA's LRC (Light Rapid Comfortable) train leaves Toronto.

The ISRS is . . . . -ble

by Liane Korfage

Canada-VIA Rail is proving that a modern rail system has an important place in Canada's passenger transportation mix.

Internally, VIA's improving fortunes are being mirrored by tremendous gains in workplace safety.

Injury and lost-time numbers have dropped dramatically; in the last two years, the injury index (a composite of injury and lost-time averages) has fallen 44%.

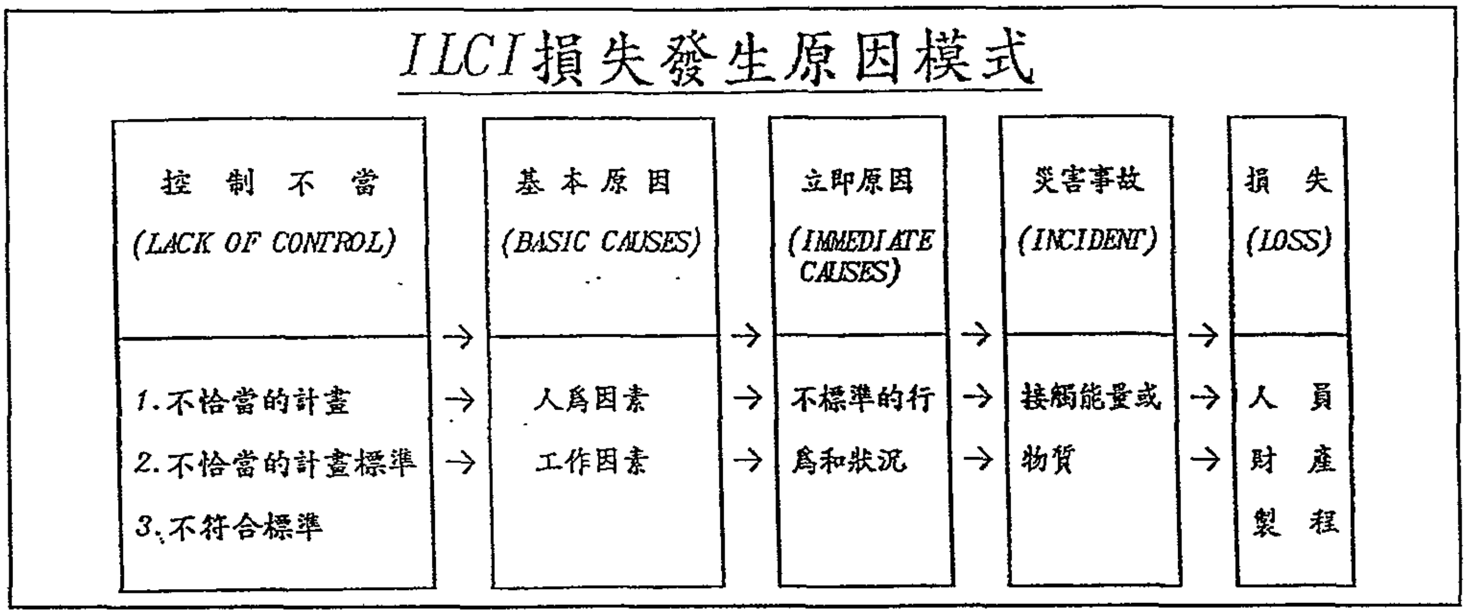
VIA's safety program was launched in 1985, the year the carrier affiliated with International Loss Control Institute. However, full implementation of ILCI's *International Safety Rating System* began in the last 2-3 years.

In January 1990, VIA underwent a restructuring due to a reduction in its annual operating subsidy from the federal government. Shaken by the downsizing, senior management laid down a long-term survival strategy which stresses three fundamental corporate values— quality, productivity and responsiveness— in every aspect of operations.

For the safety program, responsiveness was a

Continued on page 4

Loss Control Management Goes Chinese



Last fall, Taiwan's Industrial Training and Research Institute completed the translation of the International Safety Rating System to Chinese. The popular ILCI Loss Causation model is presented above. During 1992, the Institute will offer six sessions of ILCI's Modern Safety Management course and the Accredited Safety Auditor course conducted in Chinese. For more information on course dates and locations in Taiwan, contact Dr. Chun-Nan Lin at 886-3-595-6702.

way to demonstrate senior management's dedication to a safe work environment. Wherever possible, headquarters has heeded the recommendations of VIA's field safety people and local employer-employee safety committees.

Russ E.P. Blinco, VIA's corporate health and safety director said, "The program couldn't have succeeded without total commitment and support from the very top of the organization. As a result, there has been a total buy-in —a real, sincere and legitimate buy-in —by local management and employees to make this work."

> *"The broader concept of loss control management was envisaged as being the most effective and systematic approach towards the reduction of risks to people, production, equipment and the environment."*
>
> James Roche
> VIA Rail Executive Vice President,
> Chief Operating Officer

VIA's unions also support the safety program. In the equipment maintenance department, where the majority of accidents occur, the injury index has dropped by 58.3% in just two years. The improvement in 1991 was particularly outstanding. Injuries in the shops cost VIA 323.4 lost days per 200,000 hours worked in 1990. That was almost halved in 1991 — to 168.3 days — as were total injuries.

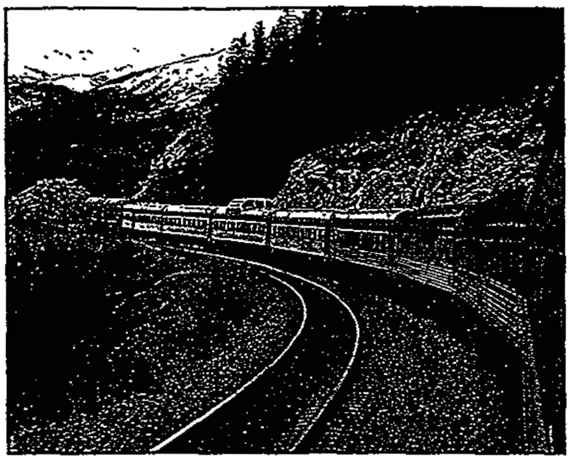
Last year, three of five maintenance shops — Winnipeg, Halifax and Vancouver — were recognized in ILCI's Advanced Award Program. Toronto rated five stars in the Standard Program.

"This was a considerable accomplishment when you consider that for all four maintenance centers, this was their very first recognition audit," notes Blinco.

The Canadian government created VIA in 1977 as a government corporation to take over Canada's declining rail passenger services.

VIA's inherited fleet was decrepit — much of it a throwback to the early 1950s. Worse, a lot of maintenance work was still done outdoors. In winter, employees were often hampered by bit-

A VIA Rail carman changes wheels in the heavy repair area.



VIA Rail passengers travel through places like the majestic Rocky Mountains.

ter cold as they struggled to keep VIA's aging equipment serviceable. Frostbite was a real occupational hazard. Quality and reliability suffered during this period, and VIA struggled for respect.

In the mid-1980s, VIA began to develop an operational infrastructure similar to that of a full-fledged railway. A fleet-renewal program was undertaken. Five state-of-the-art maintenance centers were built. Most of the repair work moved indoors.

Although safety was the initial concern, "The broader concept of loss control management was envisaged as being the most effective and systematic approach towards the reduction of risks to people, production, equipment and the environment," said James Roche, executive vice-president and chief operating officer. "This, of course, implies the application of professional management skills to the control of all losses."

VIA opted to phase in the ILCI program, and not ride roughshod over local management, in part because the railway culture can be pretty rigid when it comes to changing traditional ways. Blinco hired a staff of safety professionals to start spreading safety awareness at each location. Introduction of the *International Safety Rating System* only began in the last few years. Management at each location is free to choose how many of the 20 elements to start with.

Over the next five years, VIA's goal is to encourage all departments to embrace as much of the Advanced Program as possible.

Though the biggest hit came in 1990, VIA's government operating subsidies will shrink by a further eight percent over the next two years. To sustain its momentum, VIA must squeeze that much more productivity out of the system by deriving the maximum benefit from its human and material resources.

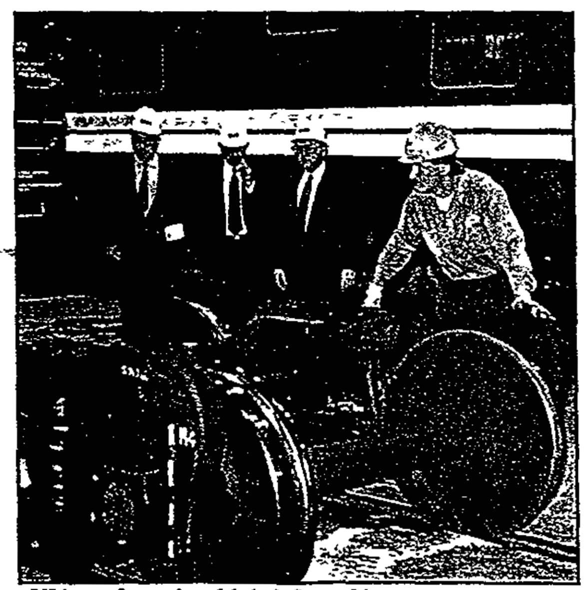
As far as Blinco is concerned, the ILCI program, with regular auditing, can help make that happen.

The reduction in injuries has brought tangible payoffs — increased productivity and reduced workmen's compensation premiums — plus a big intangible: better morale. The emphasis on safety is fostering a greater sense of teamwork in the workplace.

"We consider that the ISRS has had a strong and pervasive influence on the executive and senior management, as well as all VIA employees."

Russ Blinco
VIA Rail Corporate Health and Safety Director

"We consider that the ISRS has had a strong and pervasive influence on the executive and senior management, as well as all VIA employees," Mr. Blinco said. "Departments now more readily seek the advice of VIA's safety professionals when developing loss control/prevention methods. And the identified deficiencies stemming from regular audits invariably end up as objectives in our planning for future program growth."



VIA employee (machinist) detrucking a steam generator car for a scheduled preventive maintenance inspection. Looking on, from left to right: James Roche, Executive Vice President and Chief Operating Officer; Réjean Béchamp, Vice President of Equipment Maintenance; Mike Shaman, Director of Winnipeg Maintenance Center.

VIALOGUE

December 1991, Vol. 13 No. 6

Safety audit a welcome tool

by Russ Blinco

The word "audit" can make people shudder Notice that Internal Audit is about to visit a department usually doesn't meet with much enthusiasm.

But in Health & Safety, the word has a totally different — and somewhat more appealing — meaning.

For the conscientious facility manager, the yearly internal safety audit is a distinct and important highlight of his organization's past 12-month effort in program development.

It's a time when successes are commended and shortcomings are clearly identified — the latter taking on great importance since short- and long-term objectives stem from such identification, leading to even more success stories in the future.

It's a practical and sensible approach. Put it this way: would you accept a prescription without first seeing — or at least speaking to — your doctor? Would a bank's board of directors accept the annual financial report without first soliciting the services of an auditing firm?

The key is this: *measurement*. If I am sick, I want to know exactly how bad it is and how much of what medication I need to get well. In banking, the directors want to know how well the institution fared when measured against established objectives, the market place and fluctuating interest rates.

And for the serious corporation whose mandate it is to provide a safe, efficient and attractive mode of transportation to the travelling public, it is essential that the level of its safety performance be known (i.e. measured) and improved upon at all times.

Measure performance

This sounds very basic, and it is. But how do you measure safety performance in such a way as to make it meaningful and proactive — before any loss is permitted to happen that could result in harm to people, damage to property or loss to process.

Measurement necessarily implies the existence of standards or benchmarks, without which no comparison of quantity, value or quality is possible.

In Health & Safety, it wasn't necessary for us to reinvent the wheel. Safety principles and standards have been around now for many, many years in one form or another. What *was* necessary, however, was to determine which standards would best achieve the desired results within VIA and, more specifically, within each branch, department, shop or region.

This was done by verifying all major work areas, using the International Safety Rating System auditing tool, to measure VIA's compliance against internationally-accepted standards established by the International Loss Control Institute (ILCI), of which VIA is a chartered corporate member.

This process, conducted by internal and external licensed accredited safety auditors, enabled VIA to determine exactly where it stands in its program development — what does or does not exist, the identification of strengths and weaknesses — and helped us to draw up a road map for present and future program development.

Programs in Customer Services and Equipment Maintenance have reached a level where they warrant ILCI recognition — no trifling achievement. As a matter of fact, two VIA maintenance centres recently earned gold-star ratings from the institute (see accompanying story). Much time and hard work has been invested by CS and EM employees, resulting in many tangible benefits such as reductions in lost-time accidents and injuries, a greater safety awareness in the work place, and the pride that accompanies *any* meaningful and measurable achievements.

It must be clear by now that the auditing process associated with health, safety and loss control is not dreaded but, rather, is expected and desired. How else can safety performance be effectively measured? How can departments be recognized for their achievements and improvements over past safety performances?

More importantly, in our quest for excellence, what better way *is* there to identify program deficiencies upon which not to attach blame but rather to build and improve on.

HQ's Russ Blinco, department director, Health & Safety, is an accredited safety auditor. He has long advocated the importance of loss control, which is defined by ILCI as "any management action directed at the prevention or reduction of accidental loss" in a company. Loss-control management is "the application of professional management skills to the control of losses; a systematic approach toward the elimination of downgrading incidents and the reduction of risks to people, production, equipment and environment."

International gold-star ratings for WMC and HMC

by Bernie Goedhart

To most of us, it's probably only mildly interesting that two of VIA's maintenance centres have won gold-star safety ratings from the International Loss Control Institute (ILCI).

But to people who work in Health & Safety, this is big news. More than they'd hoped for. A breakthrough accomplishment for VIA!

"It means we've attained international recognition in the area of safety and loss control," says **Jeff Erb**, VIA Atlantic's senior coordinator, Health & Safety. "It puts us right *up* there."

Jeff is an accredited safety auditor for VIA; he's the one who performed an exhaustive audit at the Winnipeg Maintenance Centre.

International recognition

WMC earned itself a two-star gold rating, while the Halifax Maintenance Centre was awarded a one-star gold rating. ("This doesn't mean one is better than the other," says Jeff. "It's just because Winnipeg chose to be audited on the basis of 12 out of a possible 20 elements, while Halifax chose 10. The important thing is that both centres have attained international recognition.")

Jeff, who is based in Halifax, was sent to Winnipeg because "auditing protocol says you have to have an unbiased auditor; you can't audit your own area." Needless to say, he is delighted with the ratings received from the Atlanta-based institute.

"You do a baseline audit a year prior to going through the recognition audit. ILCI has a standard program that awards up to five stars, then the advanced or gold-level program that awards another five stars.

"At the gold-star level, you're up against the best in this program worldwide!" Both Winnipeg and Halifax bypassed the standard ratings and went straight for the gold.

"Word gets out quickly about something like this," Jeff says. "Insurance companies such as Lloyd's of London, for example, are always more interested in a firm that has a gold-star safety rating..."

Jeff, who came to VIA four years ago from the oil industry, has been involved with the five-star program for 15 years and has been an accredited auditor since 1986. "But at VIA we didn't really start auditing for recognition until this year..."

Management principles

Safety is not a new issue. "Over the past years, there have been many vogue safety programs — short-term programs that were in style for a while. But ILCI took a different approach. It's based on management principles — integrating the prevention of loss into the way a company does business.

"They first started using this system in Africa, in the diamond mines. There are maybe 3,000 firms involved with it internationally now, but very few of them are railroads." British Rail, says Jeff, is one of those few. "They used to have vogue programs for years, but since that major accident a couple of years ago they've opted for the ILCI approach." At VIA, "under the direction of **Russ Blinco**, we've tried to nurture this program and now are seeing the results."

Not only does the five-star rating program help "keep a cap on losses, but it also results in production successes." The program helps instill a sense of pride in employees, and "employees without pride — without a strong work ethic — don't produce." Even university MBA (master's business administration) programs now include loss control as a subject of study, says Jeff.

Controlling accidental loss to the company has always been an issue, but at VIA "two divisions have made great strides: Customer Services and Equipment Maintenance." Baseline audits have been done in Customer Services at Halifax, Montreal, Toronto, Winnipeg and Vancouver "and they'll probably go through the recognition audits in 1992." In EM, the Vancouver Maintenance Centre had its recognition audit in November and, at this writing, was awaiting the ILCI rating.

Legal Services, too, is involved — not only from the Health & Safety aspect, but "Claims and Security also play an important part. Claims people, for example, can tell you that VIA pays about $3.5 million in workers' compensation costs a year — a figure that can be greatly reduced by loss control. Not to mention minor injury costs, property damage, and so on.

"I've seen a big change at VIA Rail," says Jeff. "I see managers who are truly committed to loss prevention.

Weekly discussions

"At the Winnipeg Maintenance Centre, for example, you can go up to (director) **Mike Shaman**'s office every week and you'll see Mike at the head of the table with every one of his managers gathered around while they discuss the program." ILCI has published a 19-chapter course entitled "Practical Loss Control Leadership" which Mike and his team have studied.

Jeff admits that not everybody at VIA has bought into the program yet. "Sometimes there's a resistance to change, and the railway culture particularly falls prey to that. But in today's competitive market, we have got to use the best tools possible.

"It takes time to put in a good loss-control program. We're not alone in that." But 25 per cent of the companies going bankrupt today are in trouble because of losses "and there's no excuse for that anymore...

"You can tell a company that's involved in loss control — the ones that are truly committed to it. You'll know that the program is in place when you enter their premises because you'll see it from cleanliness to professionalism to productivity."

The year's reward

Halifax Maintenance Centre employees proudly display the vice-president's trophy, presented for one year free of loss-time injury. From left to right: Steve O'Laughlin holds an individual trophy such as was presented to each HMC employee; Brian Canning and Jim Hastings hold the vice-president's cup. *(Photo: Richard Gauthier)*

The Railway Association of Canada

FORMATION AND ACTIVITIES

The Canadian Railway Association for National Defence was formed at a convention of executives of the railways of Canada on Oct. 23, 1917, at the suggestion of the Canadian Government, to co-ordinate the activities of the various Railways with a view to ensuring the maximum efficiency in handling troops, war supplies, and other essential traffic. Shortly after its formation, it was decided, as a matter of convenience, that the name should be abbreviated to Canadian Railway War Board. After the First World War it was agreed that the work had proved of such value as to justify a permanent organization and, as a result, The Railway Association of Canada was established at the final sitting of the Canadian Railway War Board in the Windsor Hotel, Montreal, on November 8, 1919.

Letters Patent incorporating The Railway Association of Canada were issued on February 26, 1953.

Full membership consists of railways in Canada operating not fewer than 50 miles of railway. Railway companies who are not eligible for full membership may be accepted as associate members.

The purposes and objectives of the Association, as set out in the Letters Patent, are:

a) to promote generally the interests and efficiency of railways in Canada other than street railways, tramways and railways operating primarily as plant facilities;

b) to consider matters pertaining to the operation of such railways and to make recommendations in respect thereto;

c) to make representations to any government, municipality, court, board, commission, association or other group or body or to individuals on matters of common interest to members;

d) to act on behalf of the members either jointly or severally as the members may from time to time approve.

The affairs of the Association are conducted by a President/Treasurer with headquarters and staff located at 800 René-Lévesque Blvd. West, Suite 1105, Montreal, Quebec.

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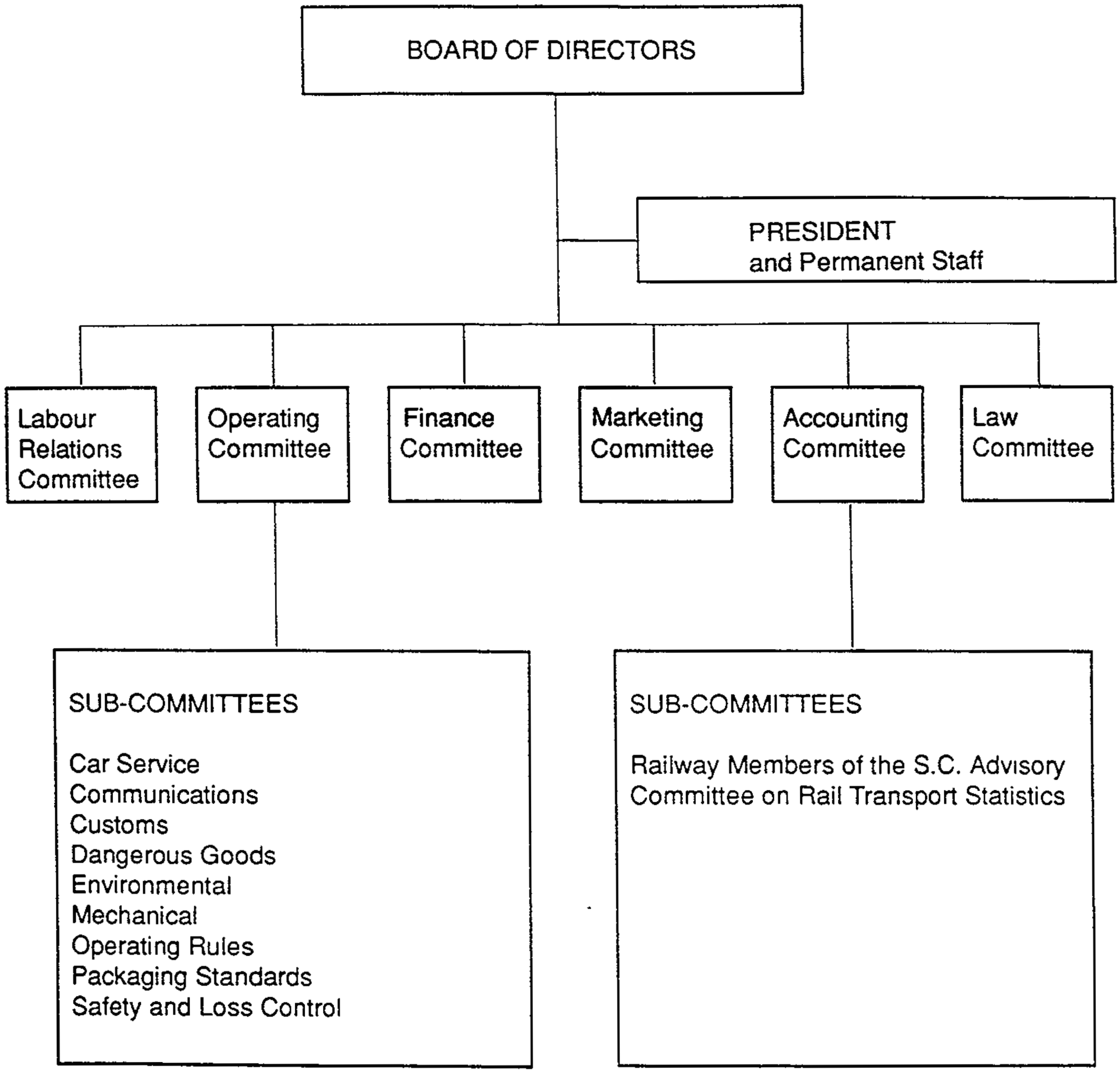

THE RAILWAY ASSOCIATION OF CANADA

It is the mission of The Railway Association of Canada:

- to promote the commercial viability and the efficient operation of the Canadian railway industry;

- to act on behalf of, or work jointly with, its member companies to promote public policy and regulation that provides equitable treatment between modes; and,

- to provide factual information on the railway industry for the public, government and industry and to provide the views and opinions of the industry on public policy issues.

MONTREAL, QUEBEC
AUGUST 27, 1990

International Rail Safety Conference

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9324

Gerald Churchill

Dependability auditing: A new function in the company (RATP)

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

DEPENDABILITY AUDITING

A NEW FONCTION IN THE COMPANY

Gérard CHURCHILL

General Management
Dependability Responsible
RATP

DEPENDABILITY AUDIT

A NEW FUNCTION WITHIN THE COMPANY

by Gérald Churchill. Gérard Le Bouquin et Bernard Beslin

General Technical Engineering

Auditing and inspection: two checks not to be confused!

Auditing is one of those trendy words. which we all tend to use too often because it sounds good, and which. as a result, takes on meanings, which are often very far from their original definition. In the minds of many people auditing has a connotation of "inspection," whereas in fact the two control procedures have two entirely different objectives. The type of inspection to which we refer in this paper, is an inspection in the etymological sense of the term. Companies sometimes use the term to refer to their Internal Audit or more often the term is associated with a procedure known as the "General Inspection" which only accentuates the confusion

A few definitions.

Auditing has its roots in the United States of the 1930s. It was an internal company procedure which was applied only to accounting and financial matters. The unique role of the first auditors was to examine the accounts. However captains of industry soon realised that these "auditors" could also judge the effectiveness of management procedures and make suggestions for their improvement. This development led to the present I.I.A. (Institute of Internal Auditors) definition of internal auditing.

"Internal auditing is an independent assessment of control procedures operating in respect of a company's (or other organisation) business activities It operates as a tool to assist the company (or other organisation.) The purpose of the assessment or control is to estimate and evaluate the effectiveness of other controls.

Its aim is to assist members of a company (or other organisation) to carry out their responsibilities efficiently. To achieve this aim the internal audit provides them with analyses, assessments, recommendations, opinions and information concerning the activities examined. It's also intended to promote effective control at a reasonable cost

The internal audit's sphere of operation includes the examination and evaluation of the adequacy and accuracy of the company's (or other organisation's) internal control procedures, as well as the quality of work input in carrying out given assignments."

Internal auditing was introduced in France at the beginning of the 1960s. The French Institute of Internal Auditors and Consultants (IFACI) was founded in 1973 The Audit Commission of the RATP has been a member of this organisation since 1975. The RATP's definition of auditing complies with the definition laid down by the I I.A

"Auditing is a procedure, which operates to assist the company's management, the ultimate purpose of which is the control and evaluation of the operation of the Company and its subsidiaries.

It involves a "second level" control, which has the capacity to operate in all areas of the company's activities (administrative, technical and financial) and in respect of all systems, whether they are operational, informative or pilot schemes, to exercise effective control over the Company and its affairs (administering its finances, managing its output, and developing its activities) and to safeguard its assets "

In the 1970s, at the same time as the development of management, financial and accounting audits, quality auditing first came onto the business scene This type of auditing, which has similar objectives to those set out above, is more specifically directed at the means of production. French Standard NF X 50-120 (which complies with ISO Standard 8402) lays down the following definition of quality auditing

"Quality auditing is a methodical and independent investigation which is undertaken to establish whether activities and results, in matters of quality, satisfy predetermined requirements and if these requirements are put into operation in an efficient and apt way so as to reach given objectives."

Quality auditing is one of the basic tools used in the process of validating the application of a quality control procedure which complies with European Standard EN 29000 (ISO Standard 9000.) The operation of this process is set out in French Standard NFX 50-136-1 Quality auditing may be an internal or external procedure. At the RATP, an external audit is carried out to satisfy the company that a railway rolling stock supplier's production is backed up by an appropriate quality control for a particular product line

Note that the confusion as to the use of terms has become accentuated in recent years with the advent of external audits particularly in the accounting sphere

Improving and maintaining the level of company efficiency.

The internal audit is a so-called "second level" control of in contrast to an inspection, which is defined as a "first level" check. The main differences between an audit and an inspection are the following.

- an audit is a non-systematic check, which is pre-programmed and officially sanctioned, whereas an inspection is a continual control which is often carried out on an ad hoc basis;

- an auditor, although attached to the management of the company, is independent from its governing hierarchy, whereas an inspector acts on behalf of a direct superior in the management hierarchy,

- an audit evaluates the systems in operation and not the competence of staff, an inspection can lead to disciplinary sanctions against members of staff

In summary, the fundamental difference is that an audit is aimed at improving the overall efficiency of the company, whereas an inspection's purpose is to maintain the level of efficiency by ensuring that there is no deviation from prescribed procedures We cannot therefore sympathise with the auditor, if his work is perceived as a type of police enquiry Often, those members of staff who are the subjects of an audit have a natural reflex to hide faults in working practices rather than bringing them to the attention of the auditor.

Dependability auditing: a technical control over new projects

As already specified above, internal auditing has to date had a limited scope, dealing only with the management process (such as accounting, financial matters and staffing.) There are no or few examples of companies where the internal auditing procedures have been extended to cover technical matters In the same way that the efficiency of a company, or even its economic survival depends on the best possible, sound financial management, the dependability of the products or services which it supplies sometimes can take on an importance which is just as crucial. This is particularly the case for a public transport company

Urban transport, particularly nowadays, is confronted with two aims which seem to be at odds with each other

- cutting costs and bringing them under control This is an objective which is achieved by major company reorganisation and by a concerted effort to improve productivity,

- to reach and maintain a high level of transport service availability and high standards of safety for the service provided (which is of paramount importance.) However, avoiding a decline in safety standards is becoming more and more difficult as the level required reaches new heights. The authorities, which are conscious of this situation, have themselves been stepping up action over number of years and becoming more demanding in this matter (safety commissions, supervisory controls.)

For new projects (e g rolling stock and fixed installations,) design is calling increasingly on the concepts of dependability (preliminary hazard analysis, the Failure Mode Effects and Criticallity Analysis, referred to as FMECA, fault trees) undertaken in co-operation between manufacturers and the RATP In particular, the matters relating to maintainability are the first to be addressed. Research and the manufacturing process favour quality control.

Hence recent rolling stock should have all the required elements for the operator to be assured of dependability The problem for the Company is therefore to maintain control over the level of dependability of its rolling stock over a period of anything from thirty to forty years, remaining conscious of the hazards to the force of habit

- organisational rigidity;

- aging rules and regulations;

- obsolescent procedures;

- processes becoming unsuitable

- skills which are lost or for which there is no renewal

This is why, in May 1990, the management of the RATP created a "dependability auditing" unit which completes the picture of the existing Internal Audit as regards technical matters. Dependability auditing is an internal audit, which corresponds to the definition set out above.

The Characteristics of dependability auditing

An independent control which works subsequently and independently

In addition to those already quoted in our comparison between auditing and inspection, internal auditing has two other fundamental characteristics.

- the logic of internal auditing subsequently works, hence it has no direct bearing on the business choices made by the Company,

- auditing is a judge and not a party to the proceedings, it has no direct role in defining standards, or drawing up of rules and procedures, or putting tools and aids into place, even if the principles behind the reasoning for such actions are very often based on the findings and recommendations of the auditing process.

Auditing can be categorised either according to the nature of the assignment, which is dependent on the expectations of the person requiring the audit, or by the subject matter under consideration.

Under the heading "nature of the assignment," the IFACI distinguishes between three types of audit:

- *The conformity audit*

This type of audit is carried out when the requisite rules exist, and they are sufficiently well-known and accepted. If the rules are written we call this procedure a compliance audit. If the rules are implied or self evident, we call it a safety audit.

The conformity audit is designed to verify that work is undertaken in accordance with the set of rules, and that the results are correct (in the etymological sense of the word)

- *The efficiency audit*

This type of audit is effected when there is no set of rules, the rules are incomplete or they have been challenged.

The aim of an efficiency audit is to improve the working rules and the quality of the results. The efficiency audit is generally designed to verify the suitability of the process used to achieve objectives and the aptness of methods and procedures

- *The management audit*

If we are more interested in the appropriateness of objectives with regards to strategy and policy, and in the adaptation of structures to aims and objectives, the efficiency audit is transformed into a management audit.

These definitions also apply to dependability auditing

As for the "subject under consideration," the IFACI still only distinguishes traditional audits for accounting, personnel and company structural matters. This doctrine is not easily transferable to the concept of dependability. we have drawn up definitions, which reflect the vocabulary used in quality auditing. There are three audit headings:

- *The product audit*

This type of auditing is essentially associated with the product's individual specifications related to dependability and the product's consistent integration into its operational sequence (e.g. auditing a brake adjuster)

- *The procedure audit*

This type of audit ensures that the rules of dependability are respected, and that they are appropriate to safety objectives. The aspects which are dealt with in particular by the procedure audit are technical instructions and procedures for design, production, modification and maintenance (e.g. audit of the maintenance procedure for a brake adjuster.)

- *The process audit*

This type of audit analyses the interaction of a body of procedures operating within an organisation controlling their suitability as regards overall safety objectives. The process audit goes beyond mere technical matters to the actual structures in place (e g. auditing the process guaranteeing minimum emergency braking)

A precise methodology.

There are eight stages to the auditing process

1 *Document research*

The audit should be conducted according to the reference materials, it is crucial that before anything else is done, all basic documentation in relation to the matter under consideration should be gathered together and studied

2. *Deciding which procedure to apply*

Once the auditor has a clear idea of what needs to be done, essentially from the documentation studied, he should think up the appropriate investigation strategy

3 *Planning the job*

Planning the job is done as a result of the investigation strategy. A preliminary investigation may be necessary before final planning is done. It will normally require a meeting with all personnel responsible for the sector to be audited.

4 *Investigation*

The investigation consists of interviews and on site visits. The investigation is undertaken from the starting point of a questionnaire drawn up in advance by the auditors. It should be drafted in such a way as to obtain answers from the interviewee that are based on fact and not opinion. On site visits help to confirm the validity of the answers given to the questions put at interview. The auditor is bound by an undertaking as to the confidentiality of the documents and information received by him.

5 *Analysis of the results*

The documentation, the reports following interviews and site visits form the subject matter of a detailed analysis to confirm that the investigation has been thorough and to ensure the validity of the results. Any finding which may appear dubious will need to be researched further.

6. *Drafting the report*

The results of the analysis and the auditor's conclusions are set out in a report, the draft version of the report is put before the main interested parties in the sector audited, for their comments or observations. These should either be included in the report or annexed by way of a schedule. The rule of thumb is to try to reach agreement on the contents of the report. The audit report is confidential.

7 *The plan of action*

With reference to the audit report, and particularly its recommendations, the Management decides on the action which needs to be taken, which is then attached to the report as a concluding note. In response to this note, the person or sector audited presents a plan of corrective action.

8. *Follow-up*

The follow-up consists of verifying that the plan of action has been properly implemented. The auditor must satisfy himself that the changes have effectively been put into operation and that they fulfil the objectives set out in the concluding note to the audit.

Tools adapted for the purpose

The analytical tools used in dependability auditing depend on the type of audit. They are obviously inspired by the tools used at the design stage which are adapted to fulfil the audit objectives.

The fact that one of the special characteristics of the audit is that it subsequently works, means its object is operational, so the auditor can take advantage of the prospective of real experience, which is rarely the case when it comes to preliminary research The upshot is that statistical analysis is a tool frequently used in auditing.

- *The tools of product auditing are the same as those used at the design stage*

The tools of product auditing are the same as those commonly used for safety research: operations analysis, hazard analysis and FMECA (Failure Mode Effects and Criticallity Analysis).

The first two tools are essentially for getting to know the product and its environment and to identify hazards associated with the product

FMECA fills in the gaps in this analysis and allows us to see if each of the faults in the constituent parts of the product are covered by a procedure (and if this is justified) To achieve this an additional column has been added to the FMECA table to specify the procedure's reference. This type of analysis is particularly useful for complex products.

- *The procedure audit has necessitated the creation of new tools*

For procedural auditing, the product auditing tools are also used to become well acquainted with the product itself from a procedural point of view In addition to these there are three other tools: the Cause and Effect (or Ishikawa) Diagram, the Task Flowchart and the Procedure Malfunction Analysis (PMA.) The Cause and Effect Diagram, which is well known to quality auditors, proves particularly useful to the auditor in identifying all elements exercising an influence on procedural matters (technical, human and organisational) and therefore helps to pin-point areas requiring investigation.

The Task Flowchart sets out the order of tasks in the given procedure in the form of a planning table. It allows tasks to be separated, to expose their relationship one to another in order to the detect incomplete branches of the procedure or those which have not been formally identified.

The PMA is an original tool created by the RATP which has the aim of evaluating the appropriateness of certain procedures. It is a transposition of the FMEA procedure where instead of the elements under scrutiny are the constituent parts of the product are replaced by the tasks in the procedure, and the causes of failures are replaced by production elements which are not consistent.

In addition to the columns used for the FMEA, additional columns for "level of gravity" and "remedial course of action" have been introduced.

The "level of gravity" is the level of potential consequences of any accident, considering various hypotheses relating to the malfunction. The "level of gravity" respecting the procedure is the level we would have obtained if the procedure had been carried out perfectly. If the resulting "level of gravity" is less than the previous value, this means that the task element is perfectly vindicated from a safety point of view If the "level of gravity" is unchanged this means that the task element is covered by a "remedial course of action" or that it is not vindicated for safety reasons but by other reasons.

Two types of "remedial course of action" are identified on the table, systematic ones which are introduced voluntarily in the procedure, and indirect ones which are not anticipated within the procedure In estimating the "level of gravity," an indirect "remedial course of action" is seen as the "worst possible case" meaning that it is inefficient.

The PMA can be transformed into an PMCA, the equivalent of the FMECA for procedures by adding an "event" column and a critical impact column. This extension is sometimes a delicate matter because the probability of an event intervening in the analysis of the procedure is very often the product of human error.

- *The tools of process auditing are the tools of global Analysis.*

Among the tools described above, only Risk Analysis and the Cause and Effect Diagram can effectively be used for process auditing The other tools can be used but only to examine a product or procedure which is critically important and for which the auditor wishes to confirm his general analysis. In fact, if we are involved in an audit relating to structure, the study of organisation flow charts is always necessary

A Strategic Company Procedure

Since its creation in May 1990, the RATP's Dependability Audit Unit has undertaken several jobs of the type described above These audits are mainly related to safety, but one audit was in fact on the subject of availability

After a breaking in period when the methodology to be employed in the procedure was being thought out, the auditing process is now fully operational. The help that it affords different departments of the company to reduce malfunctions in matters of dependability has justified its creation and demonstrates its vital contribution to maintaining the level of safety on an urban transport system such as that of the RATP Furthermore, during a time when decentralisation is taking place, dependability auditing helps check that the technical consistency between the different groups within the company is maintained

International Rail Safety Conference

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9325

George Lee

The safety audit system of the Mass Transit Railway of Hong Kong

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

THE SAFETY AUDIT SYSTEM OF THE MASS TRANSIT RAILWAY CORPORATION

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The Safety Audit System of the Mass Transit Railway Corporation

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SUMMARY The Mass Transit Railway Corporation, which operates the Mass Transit Railway in Hong Kong, established a safety audit system in 1992. The audit system forms an integral part of the Railway's safety management system, and is designed with the main purpose of assisting line management to refine their part of the safety management system. The audit system adopts a supportive and constructive approach, and emphasizes on communication. A scoring system is not used. Being a self-developed system, it can be modified to align with a shift in safety management strategy, should the need arise.

1. INTRODUCTION

The Mass Transit Railway (MTR) is an underground railway system in Hong Kong, serving the transport needs of urban commuters. It consists of 38 stations, distributed along three lines and stretches over a total route length of 43 km. The system opened in phases, with the first phase opened in 1979. The current daily patronage is 2.2 million.

The Mass Transit Railway Corporation (MTRC) is one of the organizations in the world that reviewed in depth the Inquiry reports arising from the King's Cross Fire and the Clapham Junction Collision. MTRC has maintained a very good safety record, both in terms of customer safety and occupational safety. The good safety performance of the Railway has been based on a conventional railway approach that relied heavily on the expertise and experience of a few senior management personnel. Recognizing that staff will change, and that safety expectations are increasing in the railway industry, MTRC decided to implement a new safety management system which aims for continuing good safety performance while reducing reliance on key staff.

The safety audit system, introduced in September, 1992, is an integral part of the safety management system. To facilitate understanding, a brief description will be given on the establishment of the safety management system before the safety audit system is explored in detail.

2. SAFETY SERVICES DEPARTMENT

In late 1991, a Safety Services Department was set up, headed by a Safety Services Manager. A consultant was retained to jointly with MTRC conduct an in-depth assessment of the appropriate safety management and audit systems to be adopted on the Railway.

3. SAFETY MANAGEMENT STRATEGY

The Corporation currently adopts a **"compliance-driven"** strategy for managing safety in most of its functional sections. In a number of **"high risk"** sections, e.g., Design-Signals, however, a **"risk management"** approach is being adopted. Nevertheless, after most sections have matured through the **"compliance-driven"** phase, it is the Corporation's intention to shift to a **"risk management"** strategy throughout.

4. SAFETY MANAGEMENT SYSTEM

A safety management system has been established, which involves a cyclic process of **"establishing policy - planning - organizing - implementing - monitoring - review"**.

The safety management system is initially formally adopted in the Operations Division, which is responsible for the operation of stations and trains, and the maintenance of equipment and plant. This is logical, because the inherent risks in departments directly involved in railway operations are generally greater than those providing supportive services.

The Operations Division consists of three departments:

- Operating Department, responsible for train and station operation;
- Operations Engineering Department, responsible for design, installation and maintenance of railway equipment and plant;
- Safety Services Department, responsible for policy formulation and coordination of safety management.

5. SAFETY POLICY

A Safety Policy was issued by the Chairman. The Policy establishes two goals :

- To maintain a climate of safety awareness.
- To employ management systems that would lead to continuous improvement in safety performance.

6. SAFETY TASKS AND SAFETY MODULES

Fourteen Safety Tasks, which are tasks considered important to operation of the Railway, were established to provide the necessary focus. The fourteen Safety Tasks are .

1 Information
2. Safe Systems of Work
3. Buildings, Plant and Equipment
4 Protective Equipment
5. Fire and Security
6. Training
7. Communication on Safety Matters
8. Contractors and Visitors
9 Design and Project Management
10. Accident Reporting and Investigation
11. Safety Inspections
12. Safety Performance Monitoring
13. Funding for Safety
14. Review

Each of these tasks is required to be managed using the safety management cycle.

For each task, a full description of the required management standards is provided. These management standards are called Safety Modules.

7. SAFETY RESPONSIBILITIES

It is an accepted philosophy within MTRC that "safety **is the responsibility of line management**" and that the role of the Safety Services Department is to provide an independent auditing and expert advice service to line managers, who are required for setting up and operating their part of the safety management system.

Safety Responsibility Statements are issued to all staff from supervisory level to the Operations Director. A Safety Responsibility Statement specifies the general responsibility of each staff member in regard to the Safety Tasks.

8. SAFETY MANUAL

To provide formal safety management standards, a Safety Manual was published by the Safety Services Manager. The manual specifies the requirements on the Safety Tasks, Safety Modules and Safety Critical Systems. (Note : The Safety Critical Systems are identified engineering systems that must be critically managed to maintain their integrity).

9. DESCRIPTION OF THE SAFETY AUDIT SYSTEM

9.1 Strategy and Focus

The general strategy is to maintain an audit system that is supportive, constructive and user-friendly, with the purpose of assisting work groups to set up their part of the safety management system. The audit system aims at identifying the discrepancies of the work groups' management practices, in comparison with the standards set out in the Safety Modules.

Other objectives of the audit system include hazard identification and providing assurance on the compliance status with statutory and Corporate safety standards. However, these two objectives are given a lesser focus than the main purpose of assisting line managers to set up and maintain their safety management systems.

9.2 Organization

The Safety Audit Section comprises five people : the Safety Audit Manager, a Senior Safety Auditor, two Safety Auditors and a Clerk. This establishment forms a minimum set up which allows two audit teams to operate in parallel. Normally, one of the two teams will be led by the Safety Audit Manager, and the remaining team by the Senior Safety Auditor, each with a Safety Auditor as team member. An additional team has been budgeted for 1994, to achieve the target of completing the audit of all sections of the Operations Division within two years.

9.3 Types of Audits

Two types of audit are conducted :

- The Work Group Audits
- Activity Audits

Priority is given to conducting Work Group Audits.

9.3.1 Work Group Audits

Work Group Audits are focused on the evaluation of adequacy and effectiveness of the safety management practices in a work group against the requirements of the Safety Responsibility Statements and the Safety Manual.

A joint approach is adopted in conducting Work Group Audits. While the audit team identify deficiencies in the work group's management of the Safety Tasks, the Work Group Manager confirms his acceptance of the audit team's findings and identifies improvement initiatives. Jointly, the audit results in improvement initiatives that, when implemented, should improve the safety performance of the work group.

A Work Group Audit comprises three stages :

- Pre-audit activities
- On-site activities
- Post-audit activities

9.3.2 Activity Audits

In an Activity Audit, the audit team evaluate the safety status of a multi-disciplinary operational activity or practice by comparing its implementation against established standards, which are usually Corporate Rules and Procedures and statutory requirements. In some Activity Audits, the adequacy and effectiveness of the standards themselves are also reviewed.

9.3.3 Comparison between Work Group Audits and Activity Audits

Work Group Audits and Activity Audits are two complementary types of audit, and are both needed to ensure completeness of the safety review process.

A Work Group Audit is designed to evaluate the adequacy and effectiveness of the safety management practices in a work group against the requirements of Safety Responsibility Statements and Safety Manual. Both the design and implementation of Safety Responsibility Statements, as well as the status of compliance with Safety Manual requirements, are reviewed during this type of audit. In a sense, it is a top-down approach, focusing on evaluating the adequacy and effectiveness of the overall safety management system within each work group.

In contrast, an Activity Audit is directed towards an operational activity or practice, such as fire protection, contractor working, etc., and is designed to provide an assessment of the compliance status with established standards (eg., statutory requirements, Rules and Procedures, and good management practices).The adequacy and effectiveness of the standards themselves are also reviewed in some Activity Audits.

9.4 Audit Process

The audit process comprises five stages :

- Understanding the safety management system;
- Assessing strengths and improvement opportunities;
- Gathering audit evidence;
- Evaluating audit findings;
- Reporting audit findings.

Audit activities involve reviewing background information, interviewing key staff, conducting tours and inspections, and checking documents and records.

An audit takes 5-10 working days of on-site activities and is normally conducted by a team of two.

9.5 Review of Audit Findings and Follow-up of Improvement Initiatives

A three-tier approach is adopted for reviewing audit findings and following up on improvement initiatives :

9.5.1 Upon the completion of each audit, the Safety Services Manager formally reviews the findings and recommendations with the relevant line department head. Subject to their comments, the Safety Audit Manager sends out approved action lists to "owners" of improvement initiatives and requests for action.

9.5.2 At 3 months and 9 months after the issue of the approved action lists, the "owners" are required to report to the Safety Audit Manger regarding the implementation status. The Safety audit Manager will record the information in a database.

9.5.3 Every six months, the Safety Audit Manager reports the implementation status of the audit programme and improvement actions to a Safety Committee, which is chaired by the Operations Director and comprises senior managers as members.

10. SPECIAL FEATURES OF THE SAFETY AUDIT SYSTEM

As the audit system is self-established, it has a number of special features seldom found in most "off-the-shelf" audit systems :

10.1 Tailor-Made to MTR's Needs

As the safety audit system is an integral part of the Corporation's safety management system, it is totally complementary to the latter's development. This means that the safety audit system can be modified and refined to align with a shift in the Corporation's safety management strategy at any point of time.

In the existing phase, the safety audit system focuses on assisting line management to establish a systematic and proactive safety management system, meeting the standards specified in the Safety Manual and Safety Responsibility Statements. This is appropriate, as most sections of the Corporation are currently adopting a **"compliance-driven"** safety management strategy. However, with increasing emphasis on risk management in the near future, the focus of the safety audit system can be changed to one emphasizing hazard and risk identification.

The safety audit system also fits well with Corporate strategies, core values and culture. Specifically, the supportive and participative focus of the safety audit system is compatible with the accepted safety management philosophy - **"safety is line management's responsibility"**.

10.2 Supportive and Constructive Approach

As mentioned earlier, the audit team adopt a supportive and constructive approach. Auditors focus on moving away from the classical role of "policemen" and adopting a supportive role of being "consultants" to the work groups. A Work Group Audit Report is signed by both the Work Group Manager and the Audit Team Leader. The signature of the Work Group Manager signifies joint efforts and his/her commitment on the implementation of improvement initiatives.

Auditors also focus on maintaining their credibility through logical reasoning, evidence gathering, and close involvement of the auditee and the auditee's immediate supervisor throughout an audit. The following activities are involved :

- The audit team carry out verification to substantiate their assessments.
- An interim review meeting and an exit meeting are held during each audit to discuss audit findings with the auditee.
- The audit team invite the auditee's immediate supervisor to attend the interim review meeting and exit meeting, thus allowing them to understand the logic leading to the identified findings, and laying the foundation for their subsequent support on the improvement initiatives.

10.3 Emphasis on Communication

The audit system places great emphasis on communication in all stages of an audit. Four communication meetings are held with the auditee :

- Pre-audit meeting
- Interim Review meeting
- Exit meeting
- Post-audit meeting

In addition, the audit system is promoted widely through many available communication channels :

- The Safety Audit Manager teaches auditing in safety management and audit courses. This allows the Safety Audit Manager to build up rapport with potential auditees, and provides an opportunity to emphasize the supportive, participative and constructive features of the audit system.
- The Safety Services Manager and the Safety Audit Manager give presentations at Divisional meetings, which all section heads of the Operations Division attend.
- The Safety Audit Manager also gives presentations at Joint Consultative Committee meetings, which first line supervisors attend.

10.4 Scoring System Not Used

A numerical scoring system is not used during the first round of audits. This is because different work groups may be on different baselines of safety management performance, due to various historical reasons. For example, the section responsible for signalling design is, for obvious reasons, more advanced in risk assessment than, say, the Heavy Maintenance Workshop. The goal of the first round of audits is therefore to establish the safety management baseline (i.e., compliance status of safety management practices with the Safety Manual requirements) of each work group. From the established baseline, improvement actions are devised. It is the intention to use a numerical scoring system in the second round of audits to provide a measure of the extent of improvement.

11. CONCLUSION

The safety audit system is an integral part of MTRC's safety management system. Being a self-developed system, it is dedicated to audit against 14 specific Safety Tasks that are considered the most critical to operation of the Railway. As the safety management strategy moves from a "compliance-driven" phase to a "risk management" phase in the near future, the safety audit system can be modified to place greater emphasis on risk assessment.

International Rail Safety Conference

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9326

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The management of statistics for railway accidents and operations impediments

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

THE MANAGEMENT OF STATISTICS FOR RAILWAY ACCIDENTS AND OPERATION IMPEDIMENTS

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The Management of Statistics for Railway Accidents and Operation Impediments

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The East Japan Railway Company (JR East) operates more than 12,000 trains daily over 7,500 operating kilometers, and there are occasions when railway accidents obstructing train operation and, in rare cases, train derailment sometimes occur. JR East is constantly striving to prevent the reoccurrence of railway accidents by analyzing the phenomena and causes of accidents in order to optimize its reliability as a safe transportation system.

The Ministry of Transport instituted the ministerial ordinance "Regulations for Reporting Railway Accidents" that requires railway operators to file reports concerning the circumstances involving accidents. In order to understand everyday accidents and transportation impediments in greater detail than prescribed by the Ministry of Transport ordinance, JR East has established its own additional methods for managing accident data.

The following discussion outlines ministerial ordinances and JR East provisions for the classification of accidents and impediments as well as the circumstances for accidents.

1. The Definition of Railway Accidents and Transportation Impediments

(1) The Definition of Railway Accidents

When there is a train cancellation or delay in Japan, railways investigate the occurrence to better understand it as a transportation obstruction. Of these transportation impediments, railway accidents are defined as "the occurrence of physical damage to a train in which there may also be injuries loss of human life." Consequently, regardless of the effect on the train (service is suspended or not or the delay is long or short), all transportation impediments that meet the above criteria are considered railway accidents. The same definition is used by the Ministry of Transport and JR East.

(2) The Definition of Operation Obstruction

Obstructions of transportation that result in train cancellations or delays but do not meet the above criteria for railway accidents are defined as operation impediments.

2. The Classification of Railway Accidents and Operation Impediments

(1) Types of Railway Accidents

- Train Collision — Accident in which a train collides into or makes contact with other rolling stock
- Train Derailment — Accident in which a train is derailed
- Train Fire — Accident in which their is a fire on a train
- Crossing Obstruction — Accident in which a train or rolling stock collides or makes contact with a person or motor vehicle while passing through a crossing on a road
- Railway Casualty — Accident in which train or rolling stock operation results injury or death (including pedestrians other than passengers)
- Property Damage — Accident in which train or rolling stock operation results in property damage exceeding ¥50 million.

Ministry of Transport report forms are shown in Appendices 1 and 2.

(2) Classification of Operation Impediments

① Classification according to the Ministry of Transport's "Regulations for Reporting Railway Accidents"

Since an extremely large number of reports would need to be filed if all operation impediments were reported by each railway company, the Ministry of Transport designates only the following three cases for reporting.

- Operation impediments that result in the cancellation of trains
- Operation impediments that result passenger train delays of more than 30 minutes
- Operation impediments that result in delays of more than one hour for trains other than passenger trains

Railways report operation impediments that meet the above criteria monthly using the form designated by the Ministry of Transport (see Appendix 3). However, accidents or impediments that have a major effect on society must be reported posthaste.

(2) Classification at JR East

a) Classification according to JR East's "Procedures for Reporting Accidents"

JR East's classification of accidents is slightly different from that of the Ministry of transport. Since JR East's former entity, the Japanese National Railways (JNR), was public corporation under the national government, it was required to file accident and impediment reports with the Ministry of transport, and the method for administering these was at the discretion of JNR. Since it is necessary to preserve the continuity of post-privatization statistics, the method inherited from the JNR era continues with JR East administering its own method of classification in addition to that of the Transport Ministry.

The Transport Ministry's classification method emphasizes who is the cause of an impediment. On the other hand, JR East's regulations also emphasize the form of the phenomena involved in the impediment. For example, when there is a rolling stock breakdown, JR East classifies it as the same "rolling stock breakdown" regardless of whether it is caused by a railway employee's maintenance error or a simple physical breakdown. However, under the Transport Ministry's classification system, a railway employee's maintenance error would be listed under "maintenance and repair" for railway employee causes and a simple physical breakdown under "rolling stock" for rolling stock and railway equipment causes (see Appendix 3).

JR East's method of classification is shown in Appendix 4.

As for impediments that are the result of an employee's handling error, all are examined in detail regardless of the effect on trains. As for all other impediments that originate from a breakdown in rolling stock or equipment, only those resulting in a train cancellation or delay of more than ten minutes are managed by the Transport Safety Department, and impediments resulting in train delays of less than ten minutes are managed by the department or section concerned.

b) Classification according to "major accident" patterns

The most important issue for railway transportion is the total elimination of "major accidents" that result in death or injury. The classification of 23 types of "major accidents" according to their cause and the phenomenon is shown in Appendix 5. A detailed analysis of the substance of these operation impediments shows that these are either a fail-safe phenomenon or a phenomenon that hide the possibility of a fail-out. Phenomenon that hide the possibility of a fail-out are classified following the same 23 patterns. This classification system is not according to the effects of the operation impediment on trains (whether or not there is a cancellation or whether the delay is large or small). Even if there is no train delay, the main problem is whether or not the phenomenon is linked to a "major accident." Through this classification, the roots of a "major accident" can be found, and safety measures can be taken before a "major accident" occurs.

3. Railway Accidents and Operation Impediments at JR East

JR East comprises 22 percent of all railway lines in Japan on a train-kilometer basis and 36 percent of the seven railways in the JR Group (companies resulting from the privatization and division of JNR). Table 1 shows the total number of railway accidents of JR East, the JR Group, and private railways outside of the JR Group.

Table 1 Number of Railway Accidents in Japan

	1987	1988	1989	1990	1991	1992
JR East	376	315	287	240	247	210
JR Group	926	900	893	800	761	706
Non-JR Private Railways	336	402	421	362	376	357

In the current five-year period (1989-1994), JR East is implementing priority safety investment amounting to ¥200 billion, investing heavily in automatic train stop equipment and accident prevention equipment at crossings. As a result of this investment and the development of campaigns (such as the Challenge Safety Campaign) which stimulate the independent discussion of accident prevention countermeasures throughout the company utilizing quality control methods, the whole company is involved in accident prevention and the number of accidents is decreasing each year.

(1) Railway Accidents

The circumstances involving railway accidents at JR East over the past six years are shown in Table 2.

Table 2 Railway Accident Trends at JR East

Type	1987	1988	1989	1990	1991	1992	Total
Train Collision	0	1	0	0	0	1	2
Train Derailment	4	7	7	2	3	5	28
Train Fire	1	0	7	0	0	1	9
Crossing Obstruction	247	176	156	123	116	95	913
Railway Casualty	124	130	116	115	128	108	721
Property Damage	0	1	1	0	0	0	2
Total	376	315	287	240	247	210	1675

① Train Accident (Collisions, Derailment, Fire)

Train accident is the general game given to train collisions, train derailments and train fires. JR East has had a total of 39 train accidents within the past six years. There were seven train accidents in 1992, and only one of these was a train collision. In this accident the train drive mistook the signal for the adjoining track as his own and departed in spite of a stop signal resulting in a collision with the train on the adjoining track. Furthermore, one of the five train derailments was the result of a defective axle welding on a passenger car, and the other four were the result of non-railway causes such as the collision with an automobile at a crossing. There was one train fire that resulted from a brake release failure that caused overheating of the brake and smoke, but did not result in a fire on the train itself.

② Crossing Obstruction Accidents

There are approximately 8,000 crossings under the jurisdiction of JR East, and of these, 7,000 are equipped with crossing gates.

In recent years, there has been a trend toward a decreasing number of crossing obstruction accidents with a total of 95 in 1992. The goal at JR East is to totally eliminate crossing obstruction accidents, and it is expanding its installation of crossing obstruction warning devices (an emergency button installed within the crossing that can be pushed when there is a crossing obstruction, engaging a stop signal for the oncoming train) and crossing obstruction detectors (a light beam installed in the ground detects a crossing obstruction using a loop coil, engaging a stop signal automatically for the oncoming train) (see Table 3). Many incidents of trains being stopped are the result of the use of crossing obstruction warning devices. In the case of crossing obstruction warning detectors, once the obstruction is removed from the crossing, the stop signal is automatically disengaged, but in the case of the crossing obstruction warning device, however, the stop signal is not disengaged until the warning button is turned off. In many cases, the passer-by who pushed the button runs off without turning it off, forcing the train driver to get off the train and turn it off.

Table 3 Number of Crossing Obstruction Warning Devices and Crossing Obstruction Detectors

Device	1987	1988	1989	1990	1991	1992
Crossing Obstruction Warning Device	2,678	2,783	2,969	3,188	3,305	3,532
Crossing Obstruction Detector	235	423	642	795	1,071	1,522

In addition to crossing obstruction accidents, there are operation impediments which do not involve a train's collision or contact with an automobile or pedestrian called "crossing interference." and are also included in accident statistics. These are shown in Table 4. "Crossing interference" incidents in which the crossing obstruction warning device is being used have been increasing. On the other hand, the number of incidents involving crossing obstruction detectors has not changed much in recent years.

Table 4 Crossing Obstruction Accidents and Crossing Interference Incidents

Classification		1987	1988	1989	1990	1991	1992
Crossing Obstruction Accidents		242	176	156	123	116	95
Crossing Interference		1,630	1,774	2,513	2,722	2,920	3,170
Types	Train stopped by train driver who saw obstruction	951	919	952	852	730	735
	Train stopped by crossing obstruction warning device	357	501	930	1,339	1,679	1,796
	Train stopped by crossing obstruction detector	322	354	629	531	511	639

As a result of exerted efforts to install crossing obstruction warning devices and crossing obstruction detectors, crossing obstruction accidents have decreased, although "crossing interference" incidents have increased. On the other hand, incidents where a motorist ignores a lowered crossing gate and breaks the gate to enter the crossing have multiplied. In 1992 alone, as many as 4,700 gates were broken indicating a dire need for the improvement of motorists' manners.

In 1992, there was an accident in which the driver of an overloaded truck forced his way into a crossing causing a train to derail and resulting in the truck driver's death and the injury of 88 passengers on the train. JR East is concerned about this situation and has created a crossing accident prevention project team. Accident countermeasures being carried out by this team include a public relations campaign on television, the development of campaign aimed at stopping motorists who recklessly enter crossings, the installation of crossing surveillance cameras (video cameras which take pictures of reckless drivers' faces, license numbers, and the circumstances of the incident as evidence), and the strengthening of the front of the train to protect passengers and the train driver in case there actually is an accident at a crossing.

③ Railway Casualty Accidents

Railway casualty accidents are accidents in which train or rolling stock operation results in death or injury. They do not include suicides by passers-by or passengers which are classified as "casualty (suicide)" under the heading of operation impediment accidents.

The number of such accidents occuring annually has practically leveled off in recent years. The primary causes of these accidents are a passer-by entering the tracks, impact with a passenger who accidentally falls off a platform, and contact with a passenger standing on the platform (see Table 5). Of the 48 railway casualty accidents on platforms which occurred in 1992, 42 involved drunken passengers.

JR East will soon begin to use "fallen object detector mats" as a countermeasure to prevent accidents involving falls from platforms. This device entails the installation of mats with sensors that detect weight exerted on the area below train doors at the track level. When the weight of a fallen object is detected, a stop signal is displayed. This device is currently installed on a trial basis at nine stations with curved platforms where the train driver's visibility is impared, and its effectiveness is still under study.

Table 5 Railway Casualty Accident Trends

Cause	1987	1988	1989	1990	1991	1992
Entrance onto Tracks	58	64	49	44	67	60
Falling from or Contact on Platform	66	66	67	71	61	48
Total	124	130	116	115	128	108

④ Property Damage Accident

There have been two incidents of property damage accidents in the past six years. One accident occurred in a rolling stock yard when a train driver shunting rolling stock overlooked a signal and there was a collision between rolling stock resulting in about ¥19 million in property damage. The other accident occurred within a station yard when a track maintenance car was being shunted and the station worker directing it made a mistake causing a collision with other roling stock, resulting in ¥8 million worth of property damage.

(2) Operation Impediment Accident Circumstances

Accidents classified as operation impediment accidents according to JR East regulations are shown in Table 6. There are about 10,000 of operation impediments each year. The total number of cases has leveled off in the past three years.

Table 6 Operation Impediment Accidents at JR East

Cause	1987	1988	1989	1990	1991	1992
Internal Cause	3,677	3,567	3,508	3,860	3,832	3,819
Non-Railway Cause	3,440	3,612	4,670	4,593	4,803	5,201
Natural Disaster	1,157	850	1,129	1,465	1,264	1,180
Casualties	400	452	364	345	325	340
Total	8,674	8,481	9,671	10,263	10,224	10,540

① Internal causes railway worker, rolling stock, equipment, or passenger)

Broken down according to cause, "internal causes" account for about 40 percent of all operation impediment cases at JR East. Table 7 shows operation impediments further broken down into type of accident.

The majority of "operation impediments are the result of train delays due to emergency stops caused by passengers alighting onto the tracks or a maintenance worker taking too long to retreat from the tracks for an oncoming train. "Signal handling delay" means that a railway worker made a route directing error or was late in configuring a route. Other internal causes include 20 types of accidents not included in internal causes. For example, a train might be delayed when a train driver detects a strange sound while the train is running and stops make an emergency inspection or when a passenger aboard the train becomes ill.

Table 7 Internal Causes of Operation Impediments

Type	1987	1988	1989	1990	1991	1992
Rolling Stock Breakdown	496	487	479	525	519	539
Safety Device Failure	310	337	333	413	399	351
Operation Interference	618	627	659	816	833	1,051
Signal Handling Delay	539	508	540	531	547	469
Other Internal Cause	797	805	740	795	739	659
Other	917	803	757	780	795	750
Total	3,677	3,567	3,508	3,860	3,832	3,819

② Non-Railway Causes

Non-railay causes account for about 50 percent of all cases of operation impediments, and this amount is steadily growing (Table 8). "Crossing obstruction" incidents account for a large number of non-railway operation impediments. This number is particularly large around Tokyo where the traffic volume excessive. Other non-railway operation impediments include "train obstruction" (train delay caused by stones placed on the tracks or the mischievous engagement of the crossing obstruction warning device) and "train interference" (a passer-by entering the track area or some other physical interference).

Table 8 Non-Railway Operation Impediments

Type	1987	1988	1989	1990	1991	1992
Crossing Obstruction	1,630	1,774	2,513	2,722	2,920	3,170
Train Obstruction	875	1,013	1,202	1,091	1,051	1,211
Train Interference	856	764	866	685	720	730
Other	79	61	89	95	112	90
Total	3,440	3,612	4,670	4,593	4,803	5,201

③ Natural Disasters

There are approximately 1,200 cases of operation imediments caused by natural disaster each year (Table 9).

There are many "miscellaneous disasters" such as when the volume of rain, intensity of an earthquake, or wind velocity exceed a predetermined level and train operating speeds are reduced or train runs cancelled. There are also "disaster interference" in which strong wind blows objects onto tracks causing delays and "rolling stock disasters" and "safety device disasters" in which snow or lightning cause a failure in some function of rolling stock or signals. There were 65 rolling stock disasters in 1992 and 164 safety device disasters.

Table 9 Natural Disasters at JR East

Type	1987	1988	1989	1990	1991	1992
Miscellaneous Disaster	515	395	519	674	630	464
Disaster Interference	250	242	282	402	296	447
Safety Device Disaster	211	105	151	186	166	164
Rolling Stock Disaster	119	58	120	118	108	65
Other	62	50	57	85	64	40
Total	1,157	850	1,129	1,465	1,264	1,180

④ Casualties

There are approximately 300 incidents of casualties each year. Almost all of these involve suicide. Cases in which passengers fall down because of the train shaking or injury due to broken glass caused by overcrowding on the train are tabulated as "casualty (other) (Table 10).

Table 10 Casualty Incidents at JR East

Type	1987	1988	1989	1990	1991	1992
Casualty (Suicide)	364	422	332	333	314	329
Casualty (Other)	36	30	32	12	11	11
Total	400	452	364	345	325	340

(3) Operation Impediment Accidents Fitting the "Major Accident." Pattern

The Transport Safety Department handles approximately 10,000 cases of operation impediments each year. About 10 percent of these fit the "major accident" pattern (Table 10). Operation impediment accidents which fit the "major accident" pattern are what could be called potential "major accidents." The large number of these cases does not necessarily mean that there is a high risk of their occurring.

For example, even if a train driver misses a stop signal, an improved automatic train stop device (ATS-SN) will engage the train's emergency brake, stopping the train and averting a "major accident." This means that by predicting the risk of a "major accident" at its potential stage, safety measures can be taken. Operation impediment incidents requiring reporting according to Transport Ministry ordinances account for 8 percent of all cases (600-800) (Table 11).

Table 11 Operation Impediments by Classification Method

Classification Method	1987	1988	1989	1990	1991	1992	Total
JR East Safety Measures Department Cases	8,764	9,481	9,671	10,263	10,224	10,540	57,853
"Major Accident" Pattern Cases	778	797	840	1,024	1,053	1,119	5,621
Cases Reported to the Transport Ministry	520	549	635	788	748	852	4.092

4. Recording Method for Railway Accidents and Operation Impediments

Railway accidents and operation impediments are investigated by the transport safety offices of each of the branch offices (nine branches). Reports of the results of investigations to the head office by branch offices are sent by facsimile or by using the computer network which connects the branch offices to the head office. Tests are now being made of as system utilizing optical disk device to save reports. A data base is also being constructed recording data gathered over the past six years to be used for various purposes. Details of this system can be seen in another article written at JR East.

Branch accidents or impediments that require some special feedback a commented on in facsimile message set back from the head office to the branch concerned. Common knowledge of accidents and impediments is being promoted.

5. Conclusion

It is the mission of railway companies to analyze past accidents and impediments and strive to prevent their repetition. Railway systems advance yearly, and the introduction of new technology means there is a potential for new types of accidents. The railway is the safest mode of transportation in Japan, and JR East is determined to continue this tradition.

Appendix 1

Accident Report Form

To the Director of the Transport Bureau

Name:_____ . _____ (Stamp)

Date: Year ___ Month___ Day_ .

Time of Accident Year Month Day___ Hour __ Minute __ Weather __ Name of Street at Crossing

Location Line__ Section_____ Point ___ Km

Train No. ___ Train Type____ ___Cars in Formation

Number of	Deaths:	Passengers_ . .	Non-passengers___	Train Crew___	Public___	Total_ .
Casualties	Serious Injury:	"	"	"		"
	Minor Injury.	"	"	"		"

Trunk Line Interference Restored. Month___ Day__ Hour ___ Min.___ Length: Days__ Min.__ Hrs.__

Amount of Damages Railway _____ Non-Railway_____ _____ Total__________ __

Person in Charge Name _____ Position_________ Age__ Years Employed___ Disposition___

Cause

Preventive Measures Taken

General Conditions

Appendix 2

Accident Report Form

① Type of Accident

1. Train Collision
2. Train Derailment
3. Train Fire
4. Crossing Obstruction
5. Road Obstruction
6. Human Obstruction
7. Physical Obstruction

② Type of Person in Charge

1. Train Driver
2. Conductor
3. Station Worker
4. Crossing Attendant
5. Maintenance Worker
6. Supervisor

③ Person in Charge
(a) Treatment

Train Driver
1. Signal
2. Sign
3. Excessive Speed
4. Control
5. Rolling Stock Equipment
6. Train Protection
7. Other

Conductor
1. Signal
2. Sign
3. Train Protection
4. Other

Station Worker
1. Blocking
2. Signal
3. Sign
4. Switching
5. Storage
6. Control
7. Train Protection
8. Other

Crossing Attendant
1. Premature Opening
2. Delayed Closing
3. No Operation
4. Train Protection
5. Other

Maintenance Worker
1. Inspection
2. Supervision
3. Track Closing
4. Train Protection
5. Other

Supervisor
1. Instructions
2. Confirmation
3. Other

(b) Primary Causes
1. Sleep
2. Hallucination
3. Forgetting
4. Guessing
5. Information
6. Ability
7. Negligence
8. Inappropriate Equipment
9. Other

(c) Background Elements
1. Fatigue
2. Medication
3. Anxiety
4. Mental Disorder
5. Disease
6. Poor Inspection
7. Other

④ Rolling Stock and Railway Equipment
1. Rolling Stock
2. Tracks
3. Electric Train Tracks
4. Switching Equipment
5. Signal Equipment
6. Blocking Equipment
7. Interlocking Devices
8. Crossing Safety Equipment
9. Derailment
10. ATC, ATO
11. Other

⑤ Non-Railway
1. Obstruction
2. Track Interference
3. Person on Tracks
4. Road at Crossing
5. Fire
6. Other

⑥ Natural Disaster
1. Flood
2. Wind Damage
3. Snow Damage
4. Earthquake
5. Lightning
6. Falling Rocks
7. Cold-Weather Damage
8. High Temperature
9. Other

⑦ Crossings
(a) Types
1. Type 1A (Automatic)
2. Type 1A (Manual)
3. Type 1B

4. Type 2 (Internal)
5. Type 2 (External)
6. Type 3
7. Type 4

(b) Cause
1. Cross in Front of Train
2. Head-on Collision
3. Clearance Interference
4. Car's Wheel Falls Off the Road
5. Car's Engine Stalls
6. Congestion
7. Crossing Attendant
8. Crossing Safety Equipment Failure
9. Other

(c) Object Struck
1. Passenger Van
2. Passenger Car
3. Large Truck
4. Dump Truck/Cement Mixer
5. Ordinary Truck
6. Three-Wheeled Vehicle
7. Special Vehicle
9. Agricultural Vehicle
9. Motorcycle/Scooter
10. Subcompact Car
11. Pedestrian

④ Road

(a) Location
1. Within Intersection
2. Outside of Intersection (Possible to pass over tracks)
3. Outside of Intersection (Not possible to pass over tracks)

(c) Cause
1. Sudden Crossing
2. Cutting in
3. Front-End Contact
4. Rear-End Collision
5. Head-On Collision
6. Other

Remarks

Operation Impediment Report Form

To the Director of the Transport Bureau

Reporting Year____ Month____

Name________________
Date: Year__ Month__ Day__

(Stamp)

Railway Worker

Cause
Number

1 Directions/Confirmaton | 2. Blocking | 3. Signal
4 Sign | 5 Switching | 6. Control
7. Inspection | 8. Other | 9. Subtotal

Rolling Stock & Railway Equipment

10. Rolling Stock | 11. Tracks | 12 Electric Train Tracks
13. Switching Equipment | 14. Signal Device
15. Interlocking Device | 16 Blocking Equipment
7. Crossing Safety Equipment | 18. Other | 19. Subtotal

Total

Non-Railway

Cause
Number

20 Obstruction | 21. Track Interference
22. Person on Tracks | 23. Crossing Street | 24. Fire
25. Pedestrian | 26. Other | 27. Subtotal

Natural Disaster

28. Flood | 29. Wind Damage | 30. Snow Damage
31. Earthquake | 32. Lightning | 33. Falling Rocks
34. Cold-Weather Damage | 35. High Temperature
36. Other | 37. Subtotal | 38. Total

Total

Appendix 4 Accident Classification According to JR East Regulations (Accident Reporting Procedures)

Railway Accident		Train Collision Train Derailment Train Fire Railway Casualty Railway Property Damage
Operation Impediment	Internal	Trolley Impact (collision with maintenance equipment) Rolling Stock Derailment Rolling Stock Damage Switch Damage Runaway Rolling Stock Blocking Violation (blocking mishandling) Signal Violation (signal mishandling) Miss Station Rolling Stock Breakdown Track Breakage Power Transmission Failure Safety Device Failure Loose Freight/Free Car Operation Interference Train Crew illness Signal Handling Delay Improper Stop Improper Door Handling Departure Delay Improper Equipment Handling (mishandling of equipment involving train operation) Other Internal Cause
	Non-Railway	Train Obstruction Rolling Stock Obstruction Track Obstruction Power Transmission Obstruction Safety Device Obstruction Crossing Interference Train Interference Other Non-Railway Cause
	Natural Disaster	Rolling Stock Disaster Track Disaster Power Transmission Disaster Safety Device Disaster Disaster Interference Other Disasters
	Casualties	Casualty (Suicide) Casualty (Other) (Injury or death other than suicide)

Appendix 5 Classifications "Major Accident" Patterns

1. Derailment or Collision Due to Signal Violation	Improper Signal Verification by Train Driver Improper Application of Brakes by Train Driver Rolling Stock Brake Failure (mechanical) Rolling Stock Brake Failure (handling) Poor braking Due to Snow Other
2. Derailment or Collision Due to Excessive Speed	Loss of Consciousness of Train Driver (illness, drinking) Improper Application of Brakes by Train Driver Rolling Stock Brake Failure (mechanical) Rolling Stock Brake Failure (handling) Poor braking Due to Snow Other
3. Derailment or Collision Due to Car Rolling	Improper Application of the Hand Brake Improper Installation of the Hand Brake Forgetting to Remove Hand Brake Other
4. Derailment or Collision During Shunting	Begin Shunting Without Asking for Route Improper Route Confirmation Other Improper Direction Train Driver's Improper Application of Brakes Operation of Wrong Rolling Stock Other
5. Derailment or Collision Due to Improper Signal	Incorrect Signal Wiring Incorrect Interlocking Device Wiring Incorrect Track Circuit Wiring Other
6. Derailment or Collision Due to Track Closure Procedural Error	Beginning Work without Approval Application for Approval without Confirming Last Train Beginning Work on the Wrong Track Stop Signal Error on the Signal Concerned Removal of Track Closure before Notification that the Work is Finished Other
7. Collision Due to Clearance Interference with Maintenance Car	Derailment of Maintenance Car Clearance Interference with Equipment Cover on Maintenance Car Impact with Trolley or Trolley Falls Down Other
8. Clearance Interference with Construction Machine Parts	Automobile or Crane Car Clearance Interference Construction Material Clearance Interference Construction/Maintenance Parts Clearance Interference Other
9. Impact with Fallen Tree	Strong Wind Other
10. Impact with Motor Vehicle	Fall Entrance onto Tracks Other
11. Building and Rolling Stock Clearance	Improper Confirmation of Building Clearance Improper Confirmation of Rolling Stock

Interference	Clearance
12. Derailment or Collision Due to Improper Operation Control Judgment or Directions	Improper Preparation of Operation Control Late Preparation to Stop Train Improper Filling Out of Operation Notification Improper Understanding of Conditions Other
13. Derailment or Collision Due to Crossing Obstruction	Motorist's Violation of Proper Driving Manners (collision)
14. Derailment or Collision Due to Crossing Obstruction	Crossing Gate (wiring, design, maintenance) Crossing Gate (crossing substitute lever) Crossing Gate (other)
15. Derailment Due to Natural Disaster	Collapse of Roadbed (rain, earthquake) Collapse of Cut-Out Surface (rain, earthquake) Avalanche Riding Up on Compacted Snow Strong Wind Collapsed Bridge Due to High River Water Level Collision with Large Animal Other
16. Train Contact with Employee or Cooperating Company's Employee	No Lookout (including vacancies) Improper Lookout Other
17. Passenger Falling from Train	Dragging Door Opening before Train Stops Other Door Opening Mistake Open Door (bad equipment or wiring) Other
18. Passenger on Platform Falls or Makes Contact with Train	Passenger Loses Consciousness (drunkenness) Passenger Carelessness (pushing) Murder Other
19. Derailment Due to Improper Track Maintenance	Track Overhang Improperly Attached Track Impact with Tunnel Impact with Platform Improper Track Center Spacing Sunken Track Other
20. Derailment or Collision Due to Brake or Running Equipment Failure	Brake Line Failure Control Circuit Short Axle or Bogie Frame Damage Other
21. Train Fire	Electric Locomotive High Voltage Circuit Breaker Failure Overheated Exhaust Pipe on Diesel Locomotive Other
22. Other Derailments and Collisions	Error Implementing Substitute Block System Other
23. Other	

The Management of Statistics for Railway Accidents and Operation Impediments

By Toshimasa MURAKAMI
Transport Safety Department
East Japan Railway Company

Copies of OHP Sheet

JR East's Operating Area

Length of operated route:

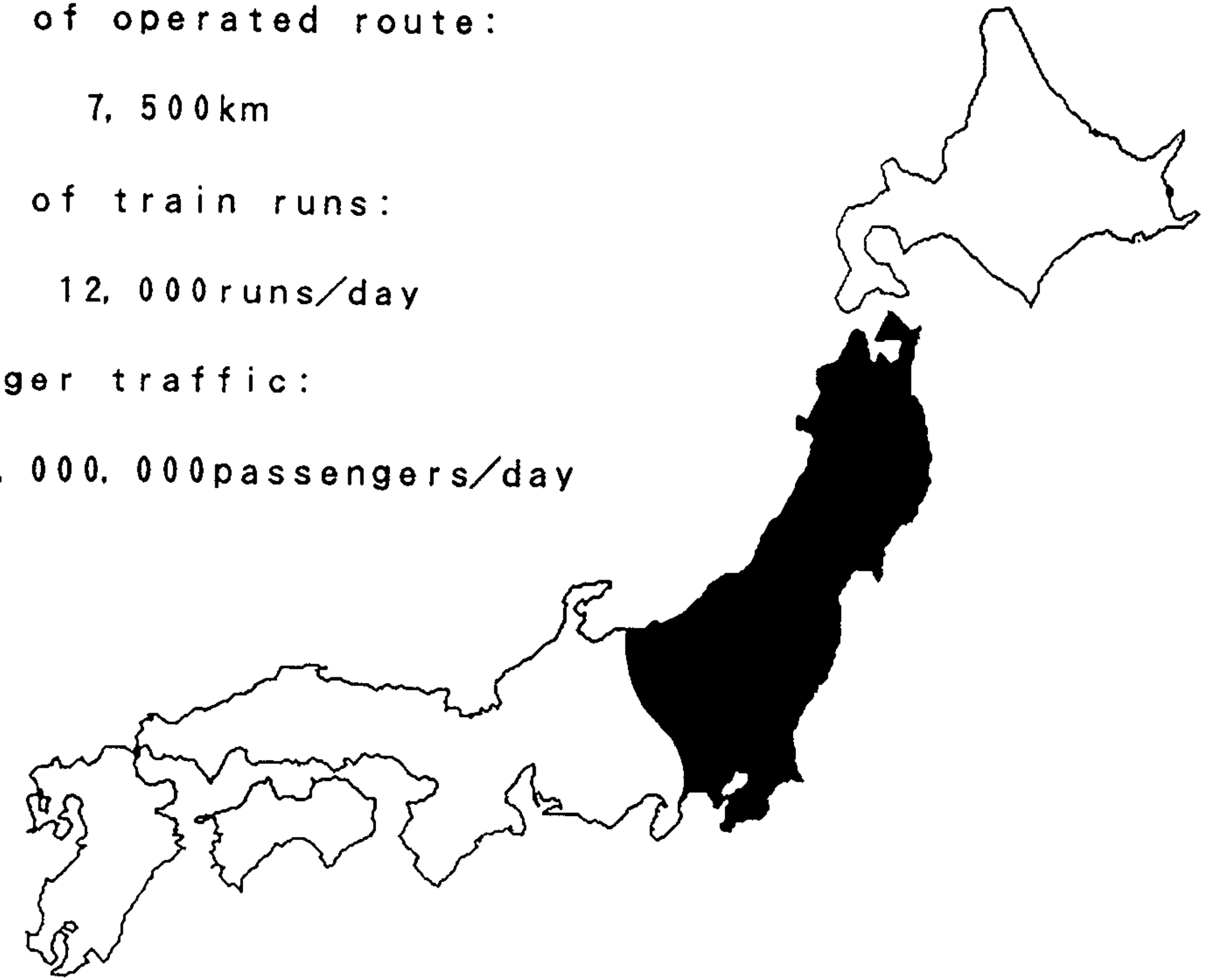
7, 500km

Number of train runs:

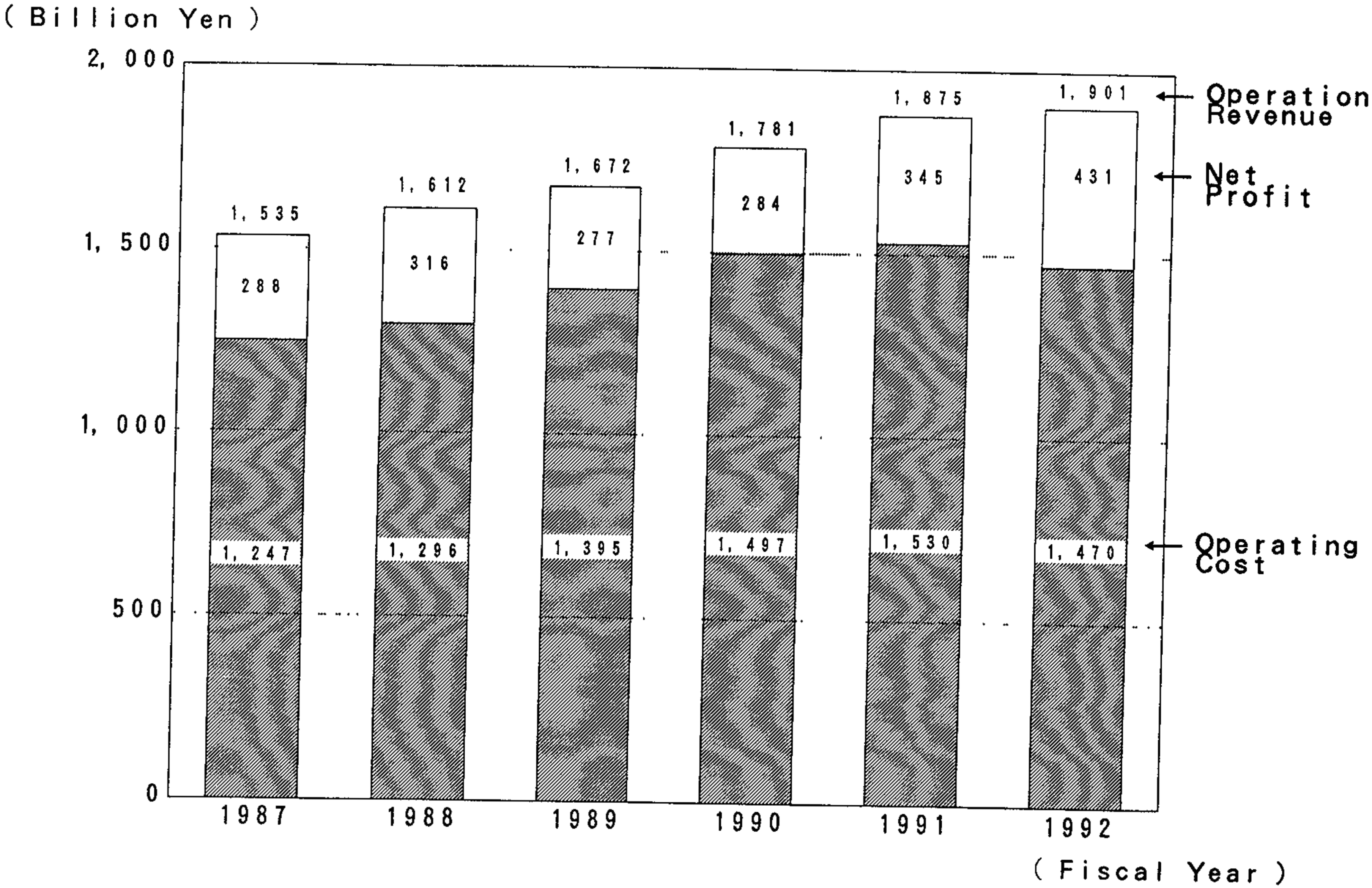
12, 000runs/day

Passenger traffic:

16, 000, 000passengers/day



JR East's Performance in Railway Operations



Definition of Raiway Accidents and Operation Impediments

Raiway Accidents : Regardless of the effect on train (service is suspended or not or the delay is long or short), the occurrence of physical damage to a train or the occurrence of injuries loss of human life

Operation Impediments : Obstructions of transportation that result in train canncellations or delays but do not meet the above criteria for railway accidents

Classification of Railway Accidents

- Train Collision : Accident in which a train collides into or makes contact with other rolling stock
- Train Derailment: Accident in which a train is derailed
- Train Fire : Accident in which there is a fire on a train
- Crossing Obstruction : Accident in which a train or rolling stock collides or makes contact with a person or motor vehicle while passing through a crossing on a road
- Railway Casualty : Accident in which train or rolling stock operation results injury or death (including pedestrians other than passengers)
- Property Damage : Accident in which train or rolling stock operation results in property damage exceeding five million yen

Reporting Criterion of Operation Impediments according to Ministerial Ordinance

- Operation Impediments that result in the cancellation of train
- Operation Impediments that result passenger train delays of more than 30 minutes
- Operation Impediments that result in delays of more than one hour for trains other than passenger trains

Operation Impediment Report Form

To the Director of the Transport Bureau　　Reporting Year____ Month____

Name ____________ Stamp
Date: Year____ Month____ Day____

Cause	Railway Worker		Rolling Stock & Railway Equipment		Non-Railway		Natural Disaster	
	Item	Number	Item	Number	Item	Number	Item	Number
a	Directions/Comfirmation		Rolling Stock		Obstruction		Flood	
	Blocking		Tracks		Track Interference		Wind Damage	
u	Signal		Electric Train Track		Person on Tracks		Snow Damage	
	Sign		Switching Equipment		Crossing Street		Earthquake	
s	Switching		Signal Device		Fire		Lightning	
	Control		Interlocking Device		Pedestrian		Falling Rocks	
e	Inspection		Blocking Equipment		Other		Cold-Weather Damage	
	Other		Crossing Safety Equipment				High Temperature	
			Other				Other	
	Subtotal		Subtotal		Subtotal		Subtotal	
							Total	

Classification of Operation Impediments according to JR East's Rule

Operation Impediments	Internal	21 Items
	Non-Railway	8 Items
	Natural Disaster	6 Items
	Casualties	2 Items
	Total	37 Items

Classification according to "Major Accidents" Patterns

1 Derailment or Collision Due to Signal Violation

2 Derailment or Collision Due to Excessive Speed

3 Derailment or Collision Due to Car Rolling

4 Derailment or Collision During Shunting

5 Derailment or Collision Due to Improper Signal

6 Derailment or Collision Due to Track Closure Procedural Error

7 Collision Due to Clearance Interference with Maintenance Car

8 Clearance Interference with Construction Machine Parts

9 Impact with Fallen Tree

10 Impact with Motor Vehicle

11 Building and Rolling Stock Clearance Interference

12 Derailment or Collision Due to Improper Operation Control Judgement or Directions

13 Derailment or Collision Due to Crossing Obstruction (Motorist's Violation)

14 Derailment or Collision Due to Crossing Obstruction (Crossing Gate Failure etc.)

15 Derailment Due to Natural Disaster

16 Train Contact with Employee or Cooperating Company's Employee

17 Passenger Falling from Train

18 Passenger on Platform Falls or Makes Contact with Train

19 Derailment Due to Improper Track Maintenance

20 Derailment or Collision Due to Brake or Running Equipment Failure

21 Train Fire

22 Other Derailments and Collisions

23 Other

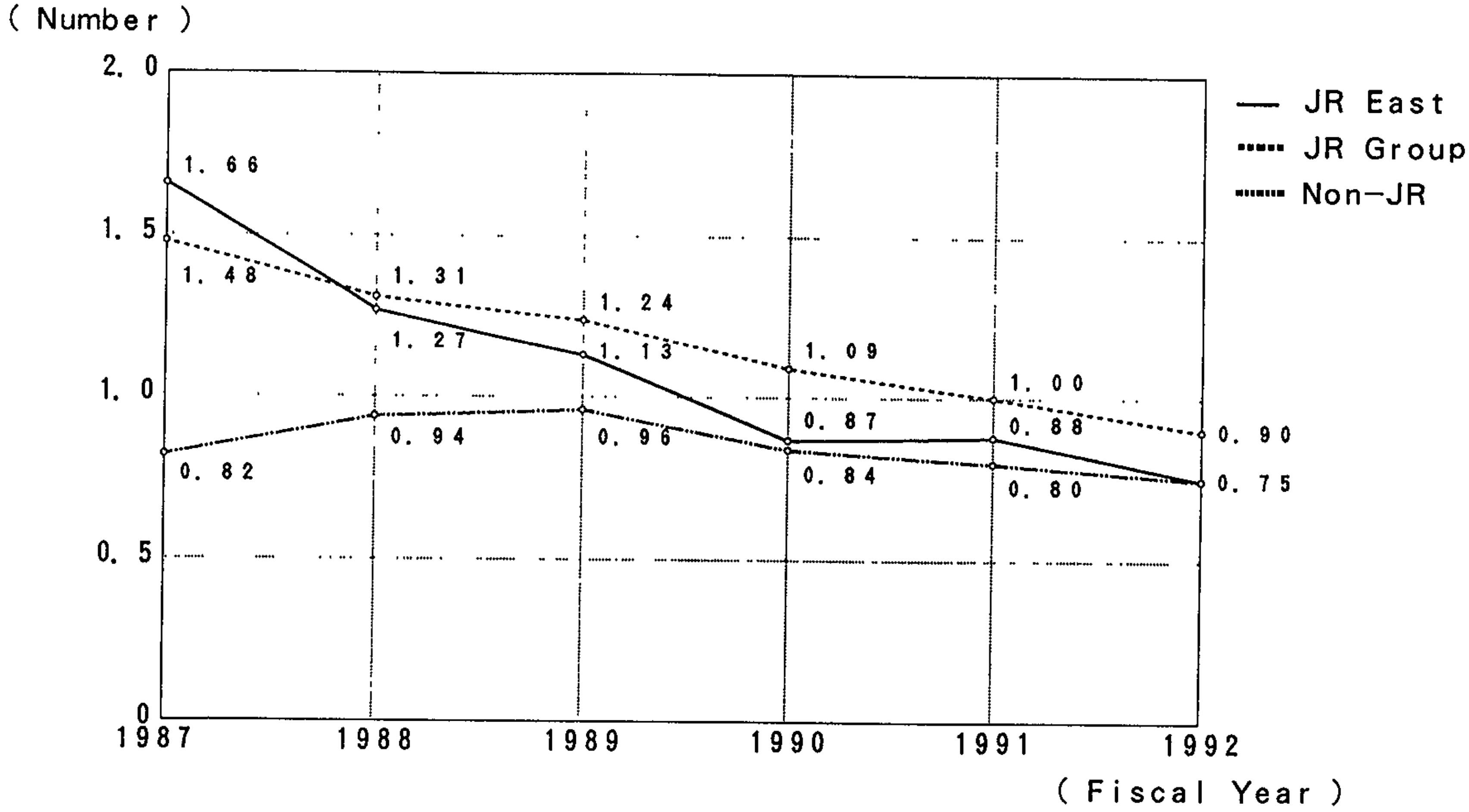
Classification according to "Major Accidents" Patterns

Example:

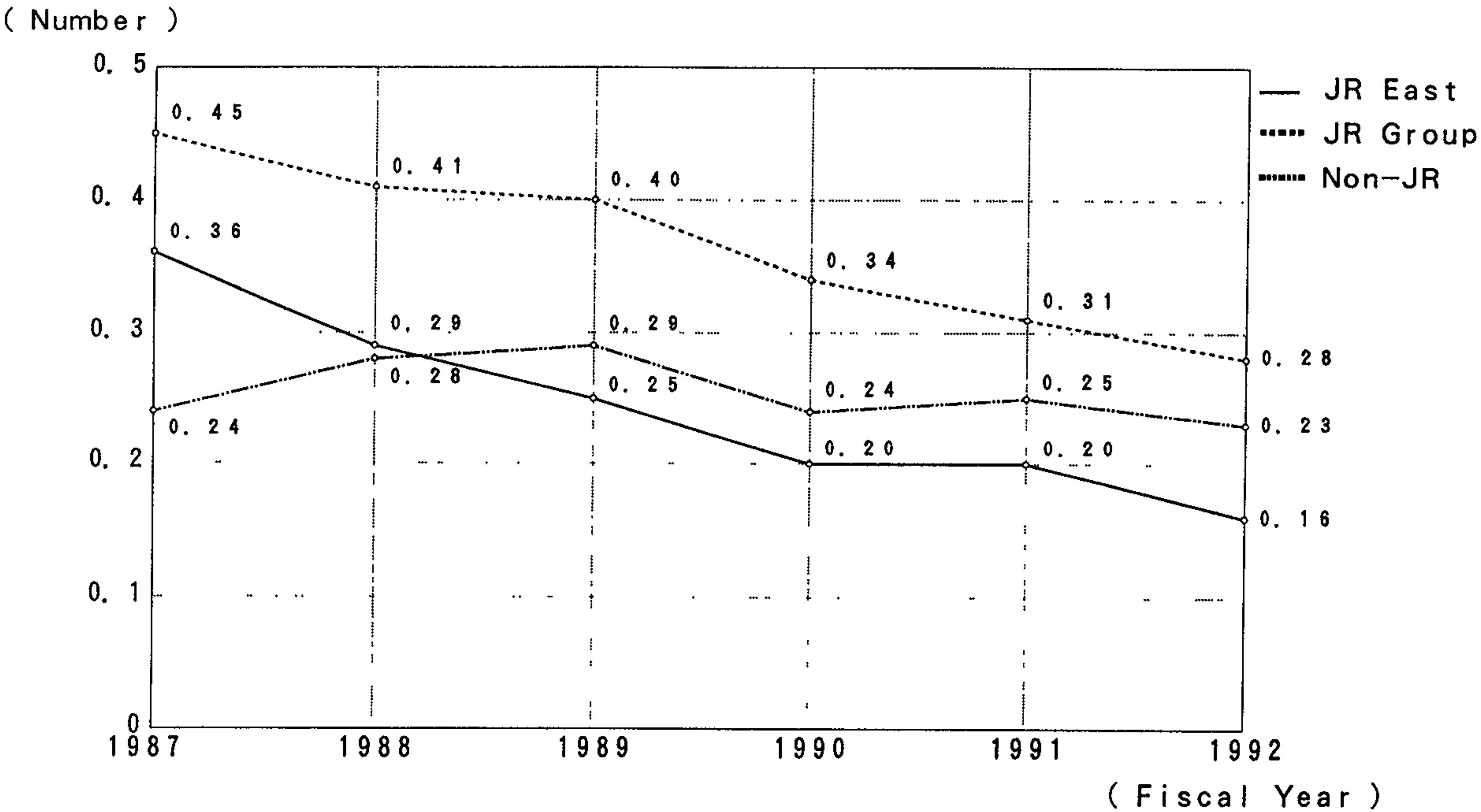
Derailment or Collision Due to Signal Violation

- Improper Signal Verification by Train Driver
- Improper Application of Brakes by Train Driver
- Rolling Stock Brake Failure (mechanical)
- Rolling Stock Brake Failure (handling)
- Poor Braking Due to Snow
- Other

Number of Train Accidents in Million Train Kilometers
(JR East , JR Group , Non-JR Private Railway)



Number of Railway Accidents in 100 Million Passenger-Kirometers
(JR East , JR Group , Non-JR Private Railways)

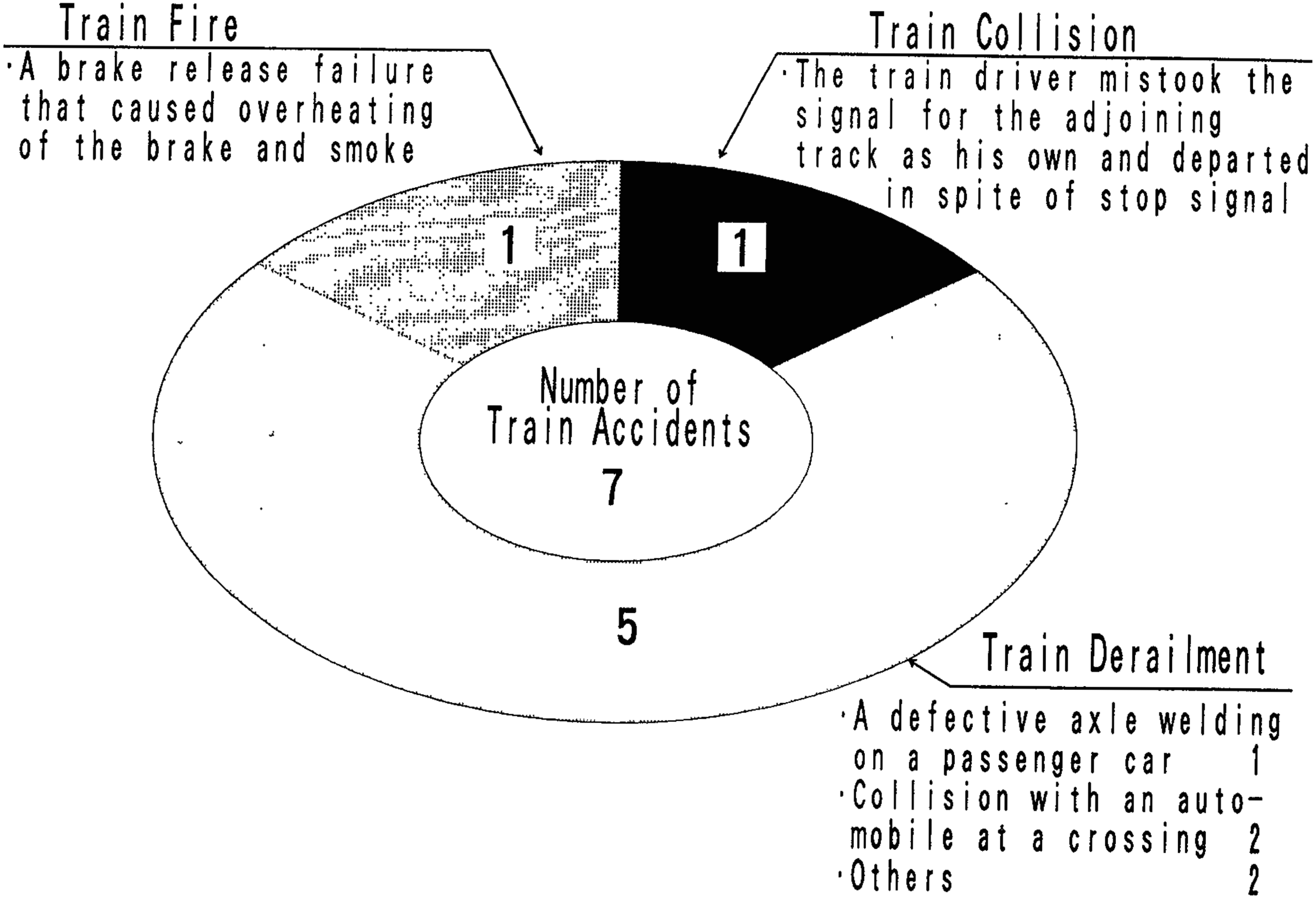


Railway Accident Trends at JR East

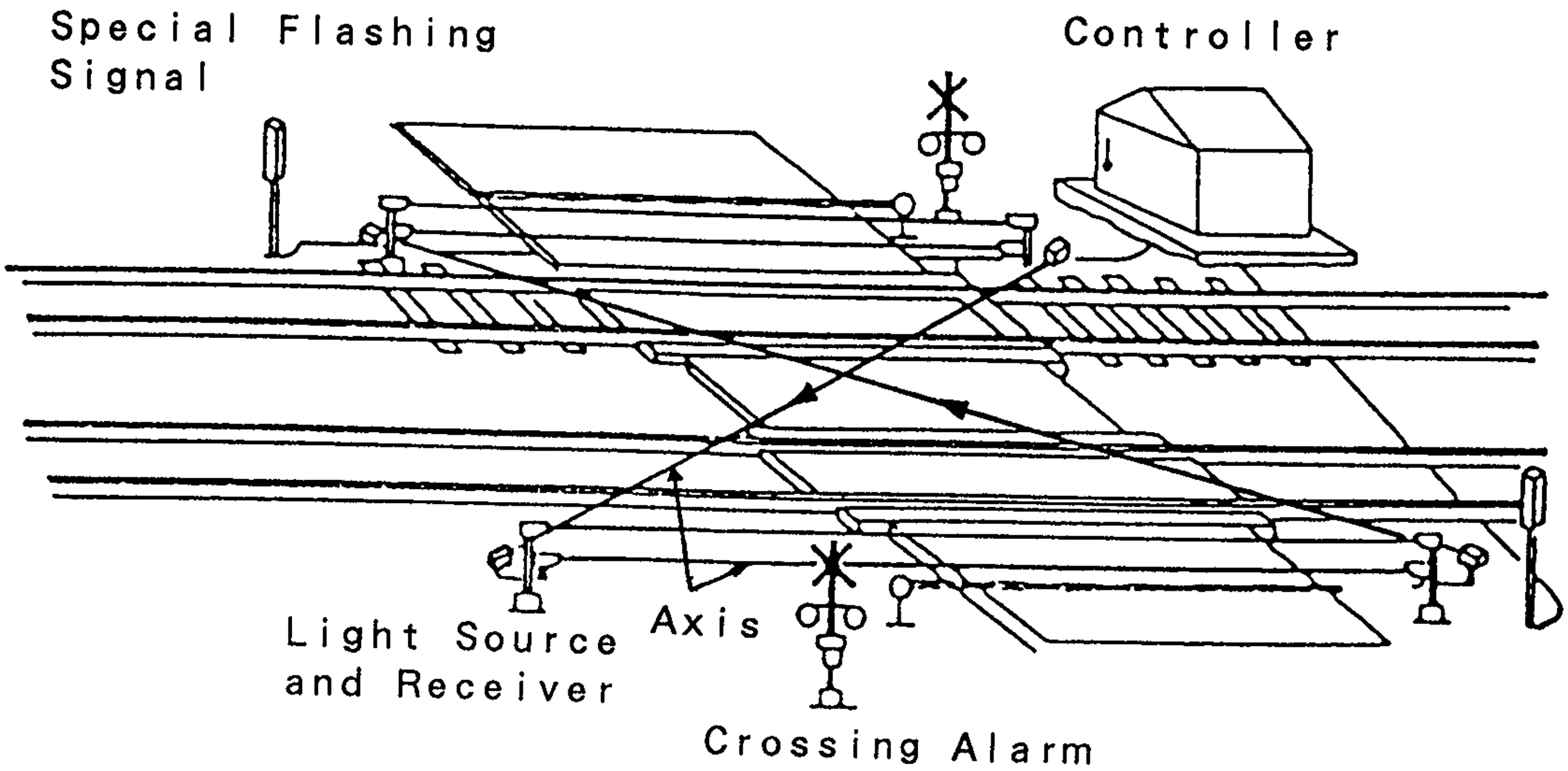
Type	1987	1988	1989	1990	1991	1992	Total	Break-down ※
Train Collision	0	1	0	0	0	1	2	2
Train Derailment	4	7	7	2	3	5	28	7
Train Fire	1	0	7	0	0	1	9	3
Crossing Obstruction	247	176	156	123	116	95	913	3
Railway Casuality	124	130	116	115	128	108	721	30
Property Damege	0	1	1	0	0	0	2	2
Total	376	315	287	240	247	210	1, 675	47

※ Accidents Caused by Employees or Facilities of JR East

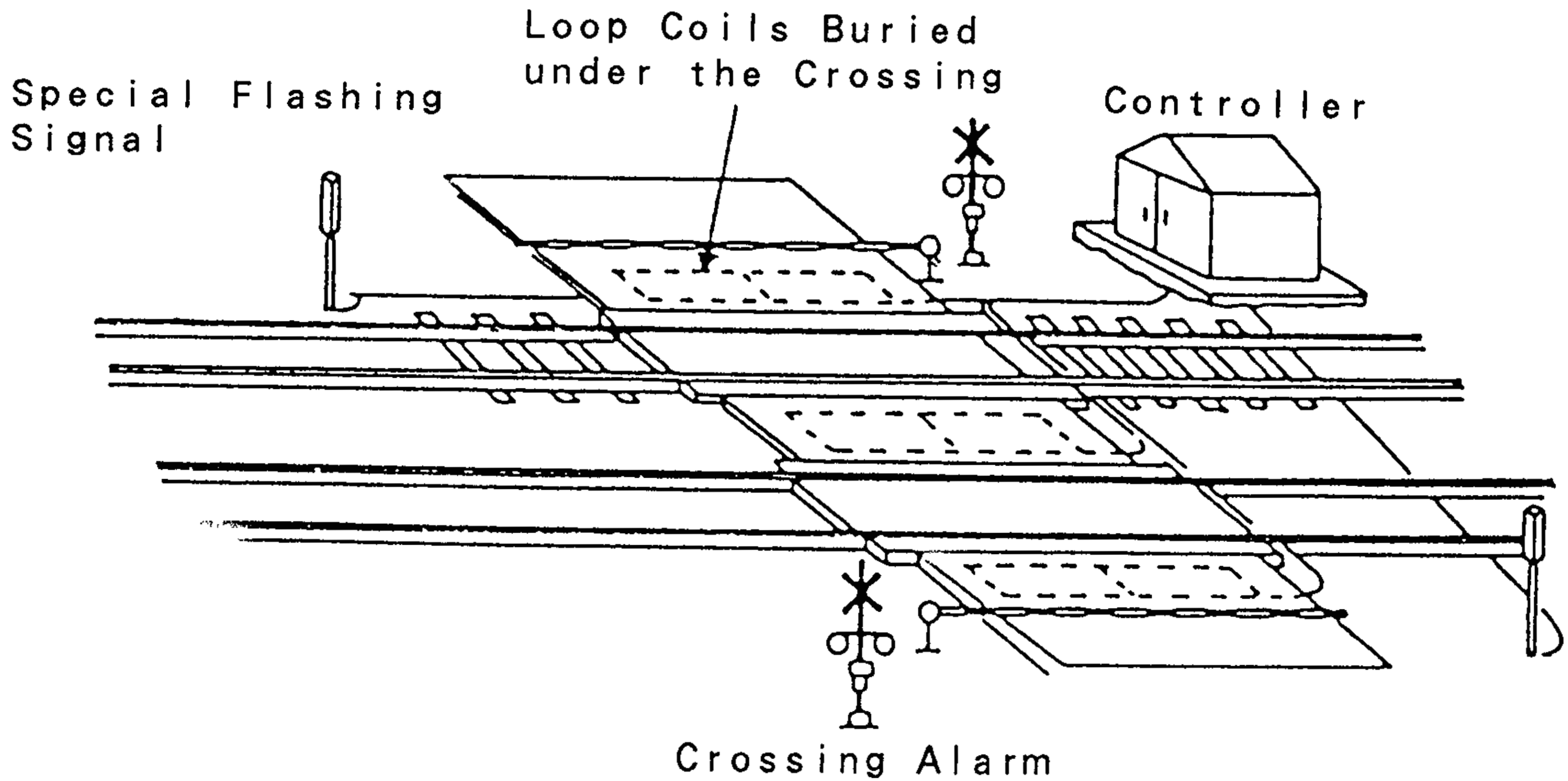
Causes of Train Accidents at JR East in Fiscal Year 1992



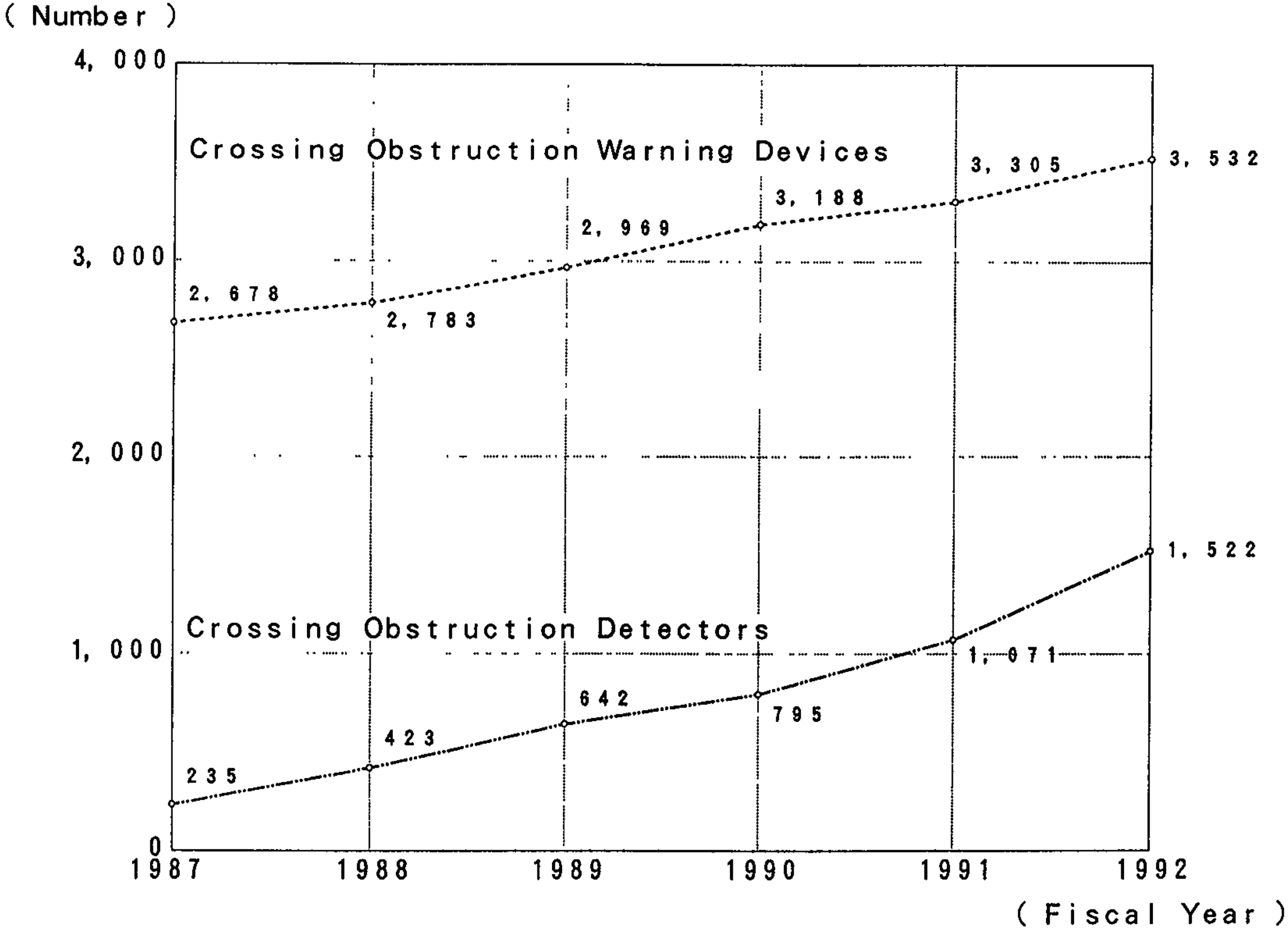
Light-beam Type Crossing Obstruction Detector



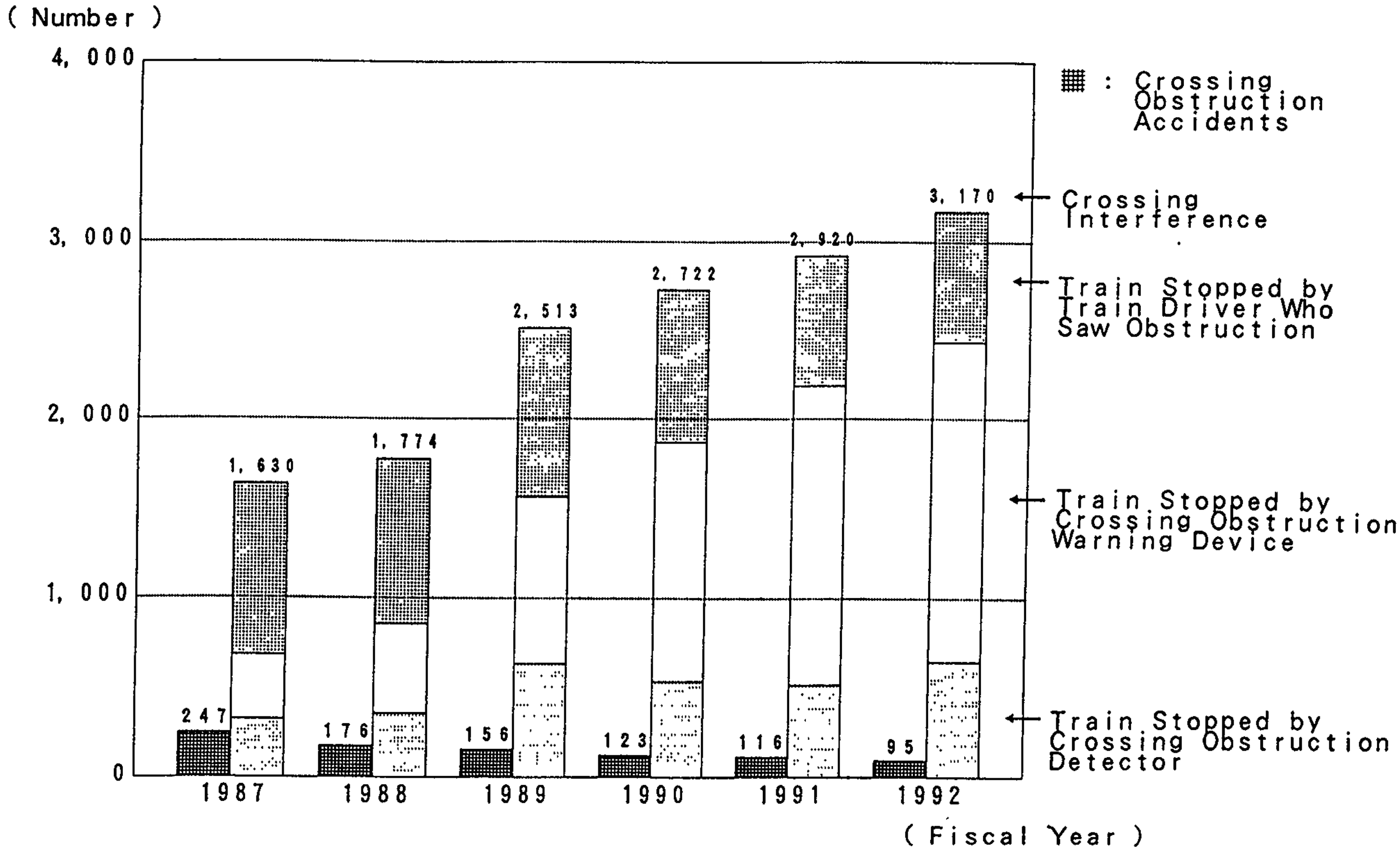
Loop-coil Type Crossing Obstruction Detector



Number of Crossing Obstruction Warning Devices and Crossing Obstruction Detectors



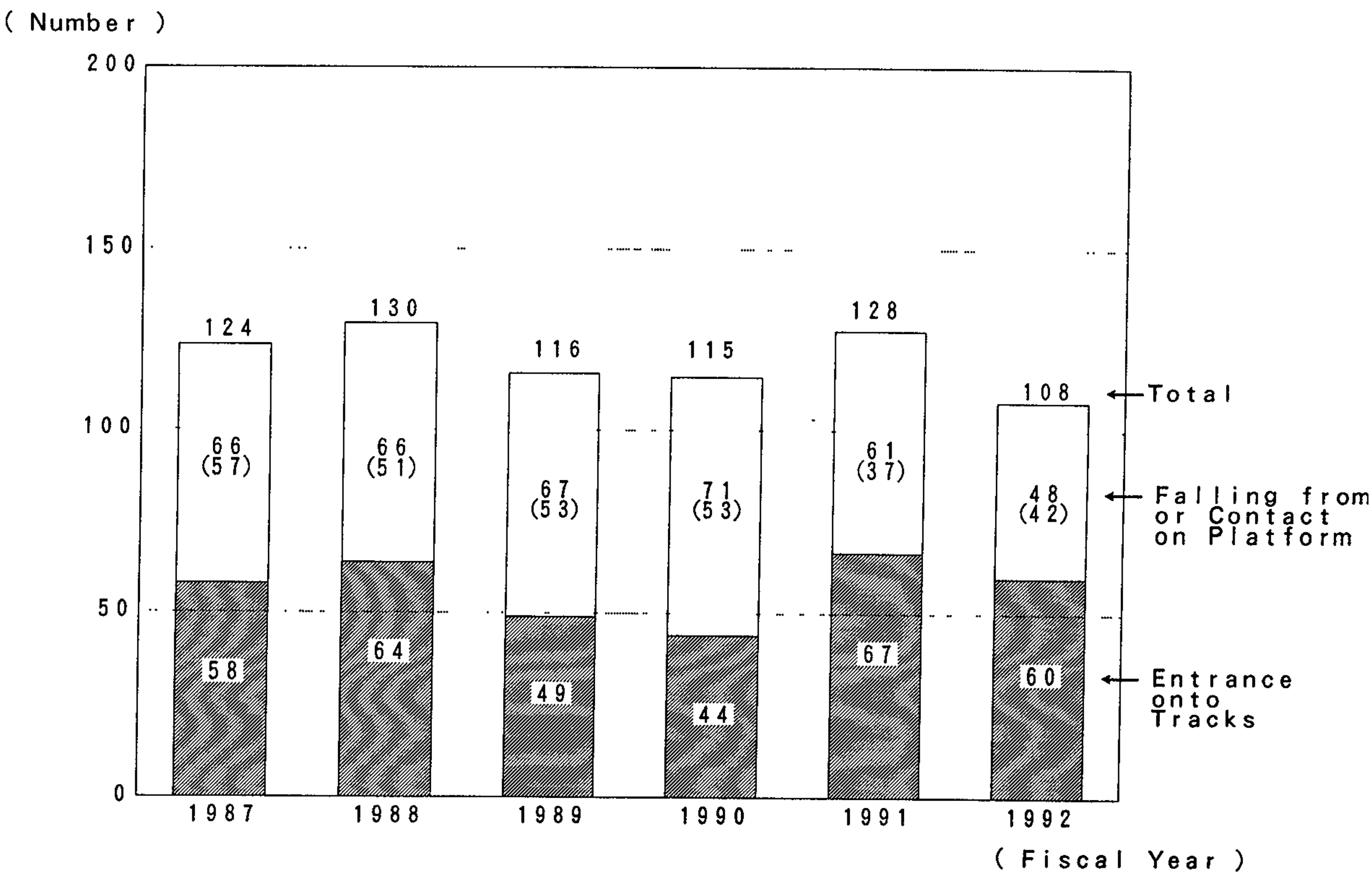
Crossing Obstruction Accidents and Crossing Interference Incidents Trends at JR East



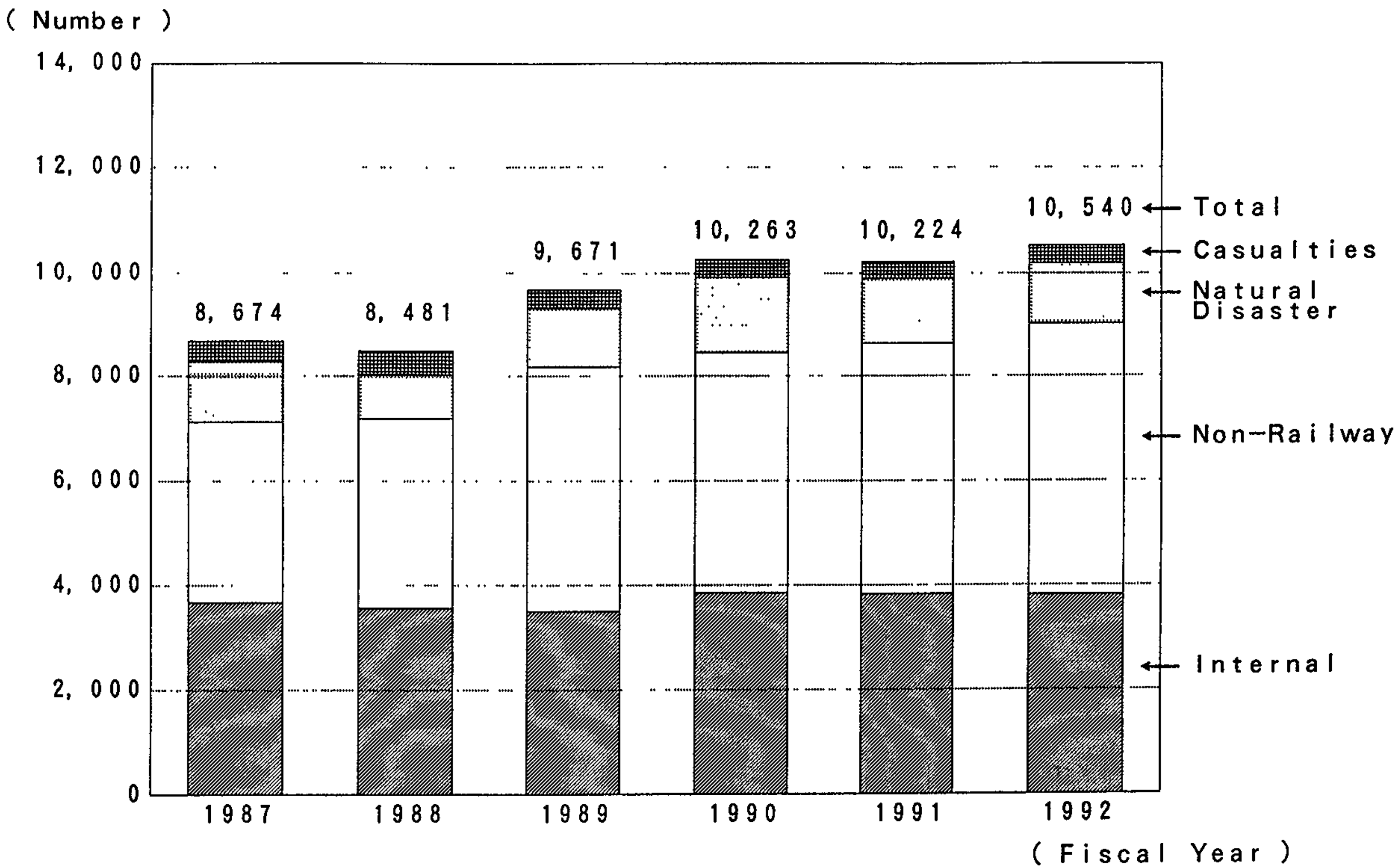
Accident Countermeasures being carried out by Crossing Accident Prevention Project Team

- A public relations campaign on television , the development of aimed at stopping motorists who recklessly enter crossings
- The installation of crossing surveillance video cameras which take pictures of reckless drivers' faces , license numbers , and the circumstaces of the incident as evidence
- The strengthening of the front of the train to protect passengers and the train driver in case there actually is an accident at a crossing

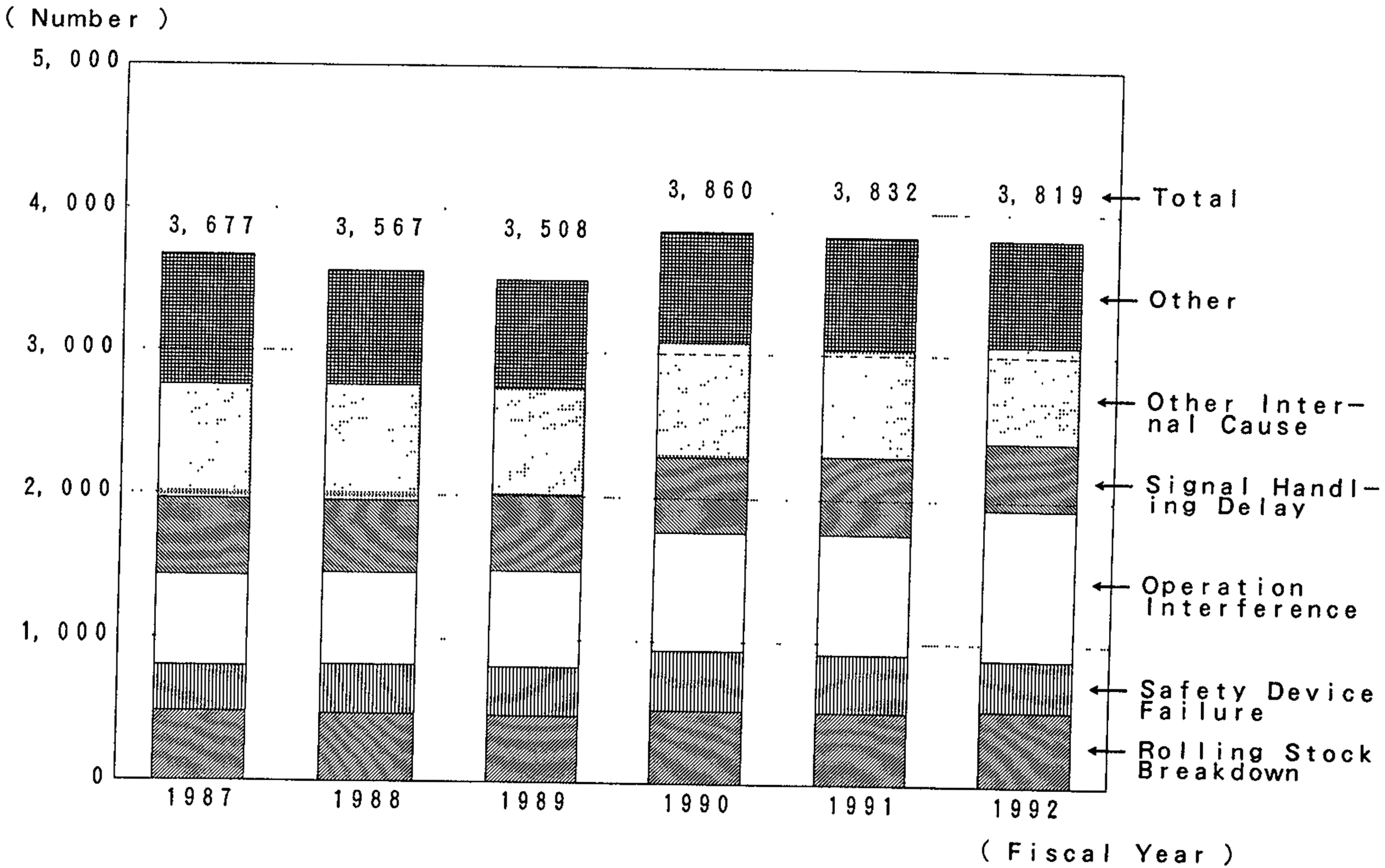
Railway Casualty Accidents at JR East



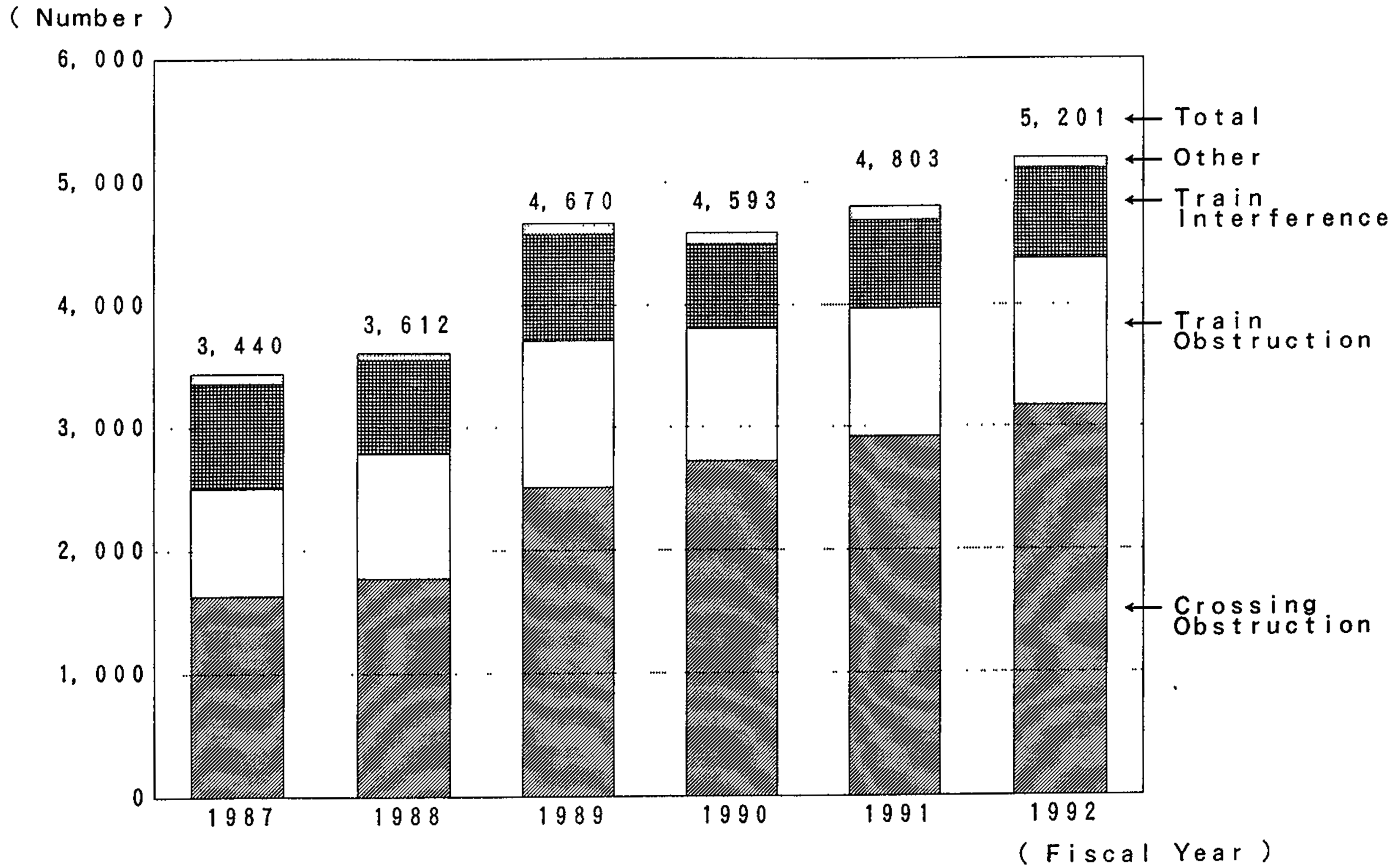
Operation Impediments at JR East



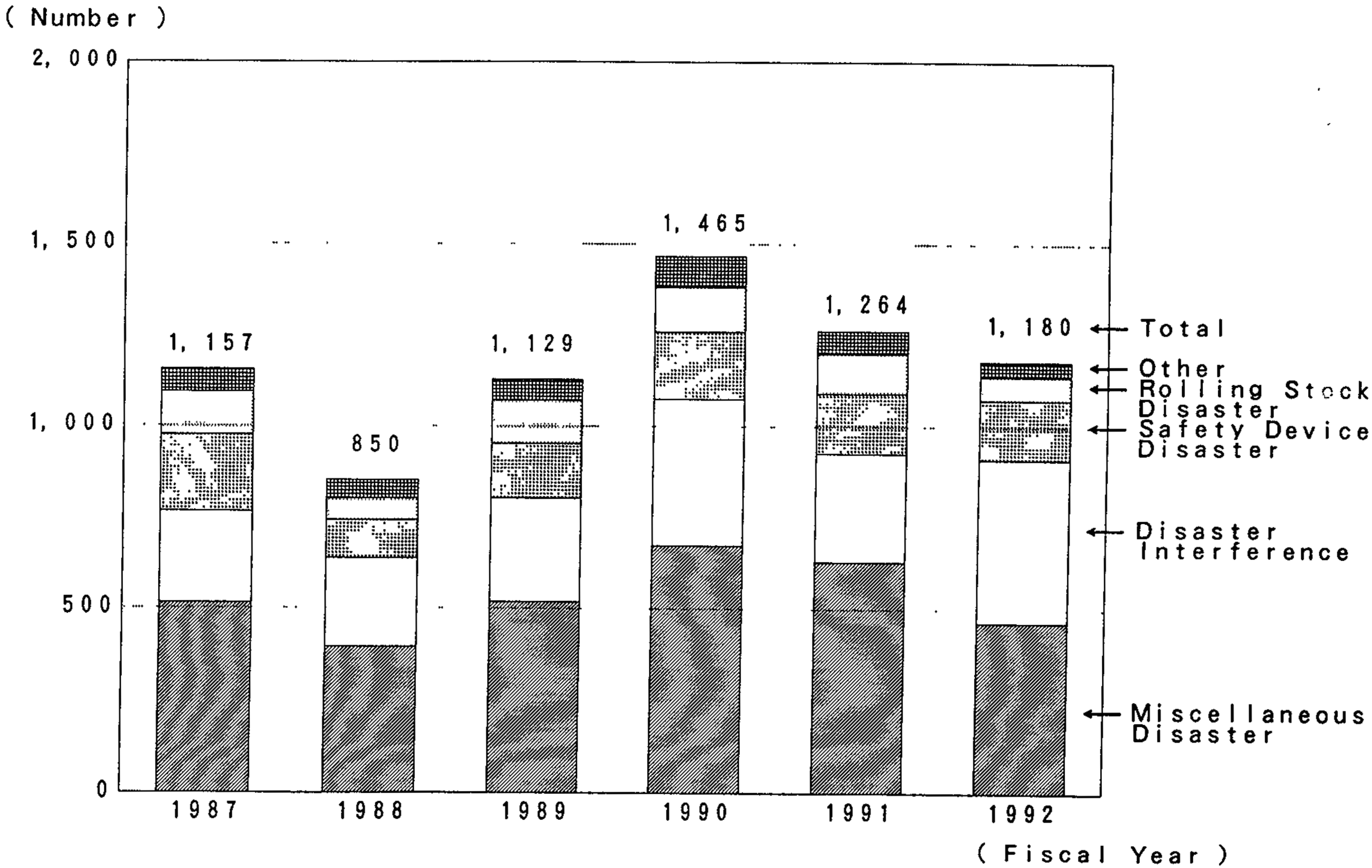
Internal Causes of Operation Impediments at JR East



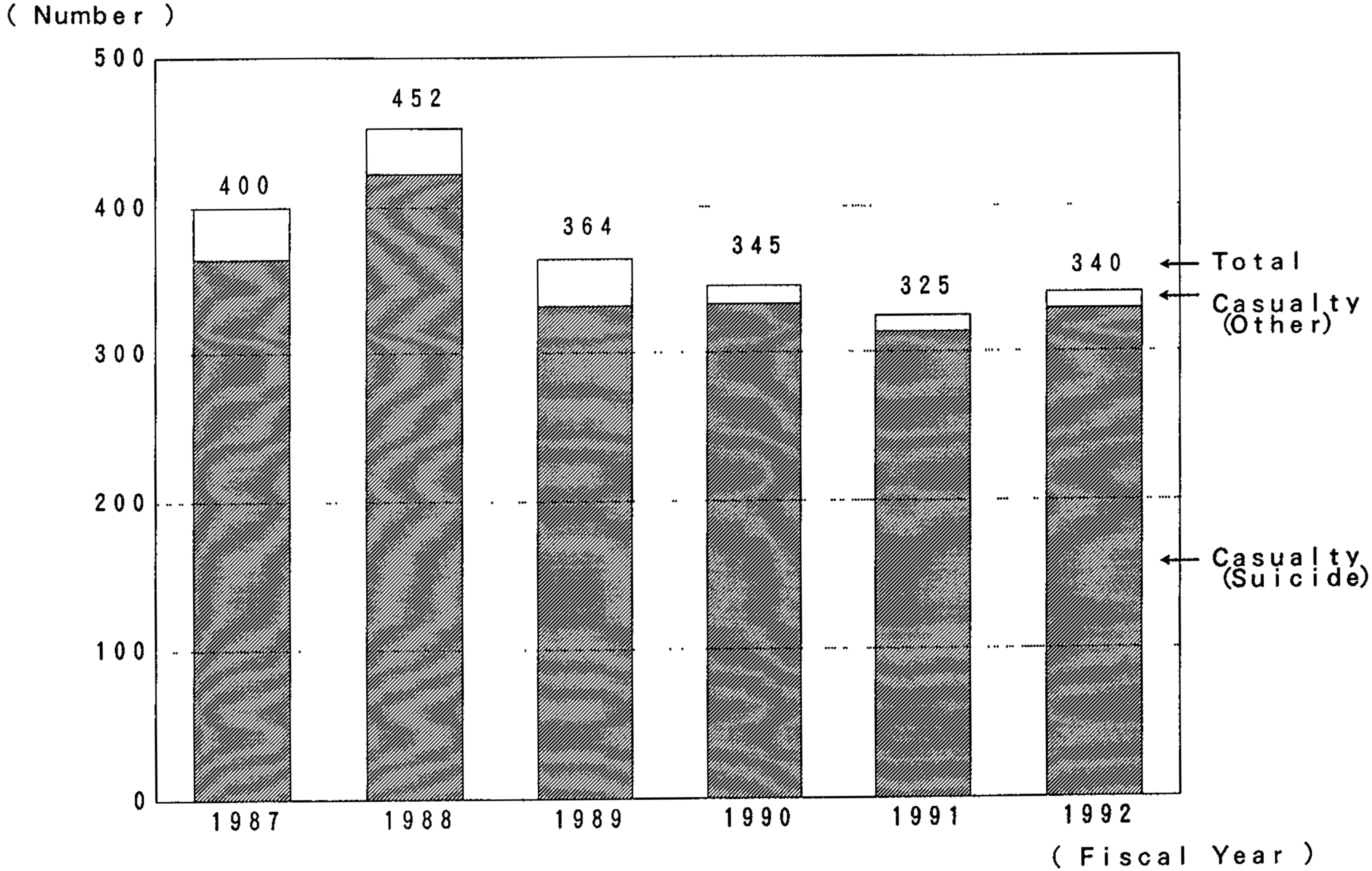
Non-Railway Operation Impediments at JR East



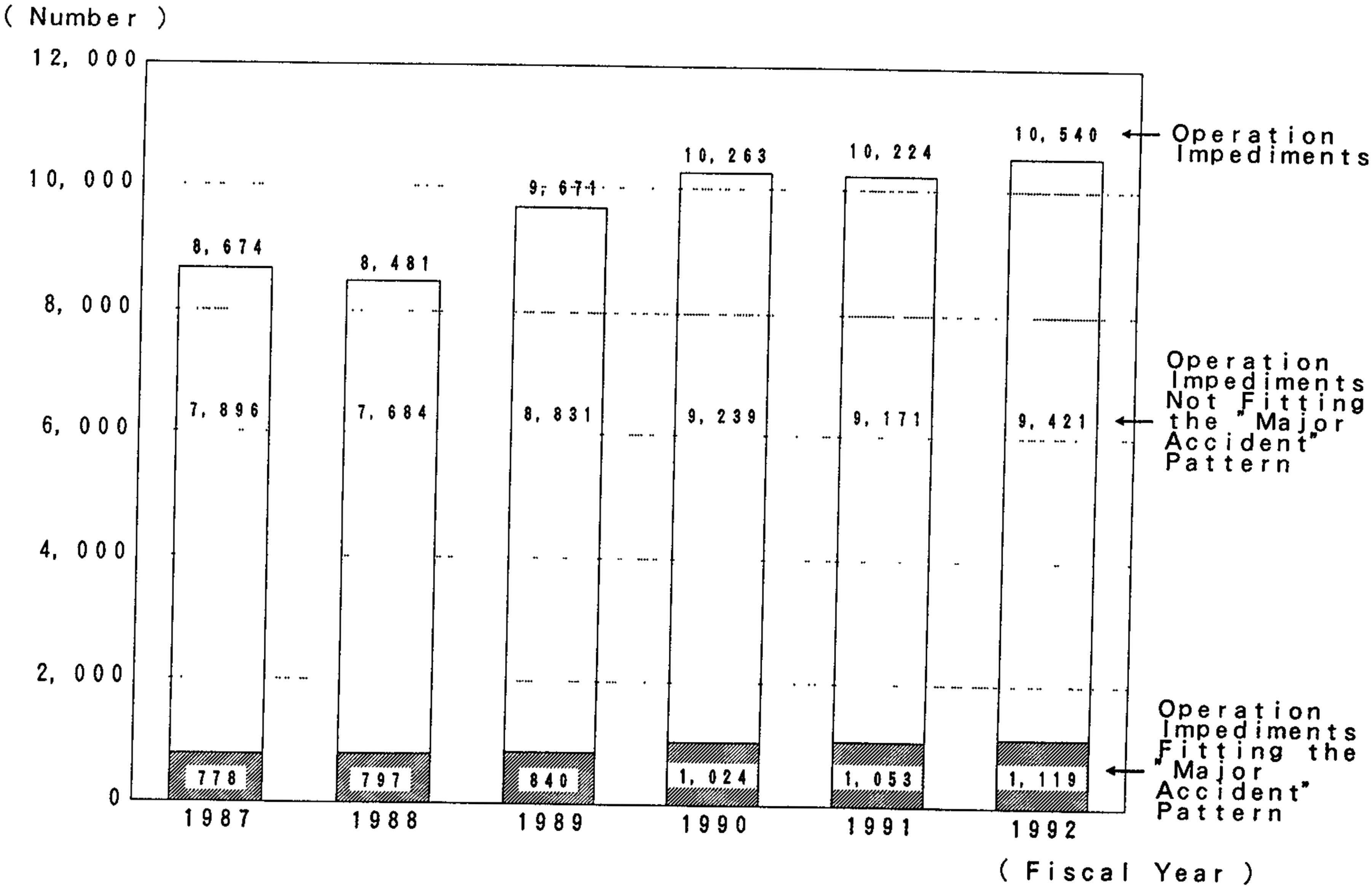
Natural Disasters at JR East



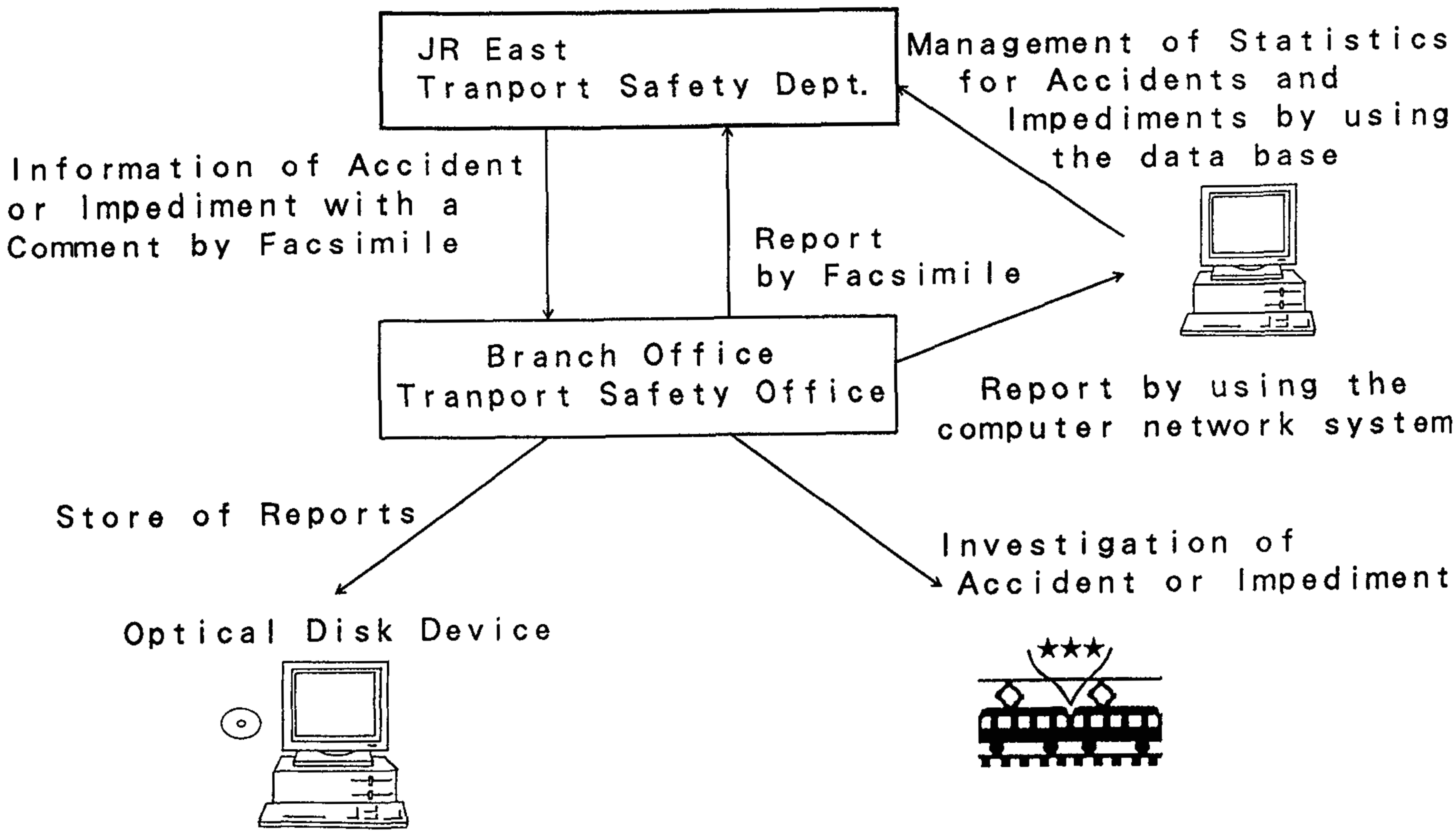
Casualty Incidents at JR East



Number of Fitting the "Major Accident" Pattern



Recording Method for Railway Accidents and Operation Impediments



International Rail Safety Conference

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9327

David Maidment
Michel Joing

Exchange of Safety data between railways

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

EXCHANGE OF SAFETY DATA BETWEEN RAILWAYS

David MAIDMENT

Head of Safety Policy Unit
British Railways Board

Michel JOING

Head of Safety Studies Center
SNCF

Memorandum to International Railway Safety Seminar

Angers, October 1993

SAFETY DATA EXCHANGE

Joint Paper by David Maidment, British Rail and Michel Joing, SNCF.

Introduction

At the Wellington Conference in 1992, it was agreed that interested railways would establish ways of exchanging safety data that were relevant to the management of risk. Existing UIC statistics were not helpful, in that they were too old and ill-defined to make proper comparisons and identify best practice.

In February 1993, six western European national railway systems (UK, France, Netherlands, Belgium, Switzerland, Germany) established a prototype system, and, by the summer, had exchanged or proposed data on some nine topics of key interest to the participants.

Further interest has been expressed by railways in New Zealand and Australia, also the Mass Transit systems of Hong Kong and Singapore. This paper seeks to explain progress so far, and makes proposals for widening the number of railways involved.

Data Exchange Undertaken

The European Railways involved agreed that any data exchanged should be defined as precisely as possible, and normalised against populations of staff, equipment or workload, as most appropriate.

The following subject areas have been analysed and the broad results are attached as appendices:

i) Trackside Safety

Fatalities and injuries to employees working on the track hit by a train. Data broken down by activity (track maintenance, signal installation or repair, overhead electric line maintenance, shunting), whether employee or contractor, normalised against the number of employees in each specified activity.

ii) Falls from Trains

Fatalities and injuries to passengers falling from trains when joining, alighting, or en route. Also any employees so injured. Statistics normalised against the number of passenger journeys per year.

iii) <u>Dangerous Goods - Serious Accidents</u>

Incidents involving serious outcome - fire, explosion, derailment, collision or significant release of toxic substances, normalised against workload (number of dangerous goods transits in tonne kilometres per annum).

iv) <u>Accidents at Level Crossings</u>

Collisions between trains and vehicles or pedestrians at level crossings, by type of crossing (protected manually by barriers, automatic barrier crossing, automatic crossing with lights only, open crossing unprotected, pedestrian crossing, ie footpath in open country); data normalised by number of type of crossing, car fleet numbers in country, number of train kilometres per annum, as available.

v) <u>Serious Accidents following "Signals Passed at Danger"</u>

Accidents causing injury or fatality to employees or passengers, with description and indication of type of collision (head on, converging or rear end), normalised by train kilometres per annum.

At the most recent meeting of the railways concerned, it was agreed to add:

vi) <u>Failure of Monobloc Wheels (SNCB request)</u>

To establish experience of other railways following the potentially catastrophic failure of small diameter monobloc wheels on international freight carrying vehicles; normalised by number of vehicles with this type of wheel.

vii) <u>Failure of Axle Bearings (BR request)</u>

To identify experience and hot axle-box detection policy, of contributing railways. Number of failures causing collapse, derailment and potential injury or fatality, normalised by number of passenger vehicle/freight vehicle kilometres per annum (separately).

viii) <u>Accidents at Passenger Station Crossings (SNCF request)</u>

Fatalities and injuries to passengers crossing lines on the level at stations, either legally (where no other means provided) or illegally (where subway, bridge etc provided); normalised by number of passenger journeys/stations.

ix) <u>Trespass and Suicides (BR request)</u>

Number of fatalities and injuries, analysed by type of incident where possible (eg age band of victim, whether involved in vandalism, suicide, drunk etc); normalised by track mileage, population.

Lessons Learned

Although the concept has been supported by all the railways involved, the obtaining of data has met with mixed success. Definitions have been hard to agree, and some qualifications of data have been necessary. Not all railways have had access to data in the form required. However, a useful start has been made, and some points of interest have emerged, especially on level crossing accident frequencies, train falls and trackside fatalities.

If we persevere, a number of benefits can accrue:

- identification of best practice
- shared research
- communal problem solving
- benchmark for own safety performance
- uniformity/improvement of standards.

Way Forward

A number of issues have to be addressed to consolidate work done, and reap full value.

i) Confidentiality of Data

There is concern, especially among some railways not yet involved, that data could be misused. This could increase as privatisation affects more railways and safety data could become of legal or commercial importance.

It is suggested that all participating railways provide the "collator" with full details, but only average data (with the top and bottom range of performance) is published, without attribution to individual railways. Each railway could then compare its performance to the average and the range.

Best practice railways could be asked to describe their systems of work for that activity for subsequent international safety seminars.

ii) Administration

At present, SNCF has collated and published data for the group of participating railways. It is apparent that the data is most useful when a railway is about to undertake a particular review, or study.

It is suggested that any participating railway wishing to initiate a new type of data exchange:

a) designs the proforma, defines the data and normalising factors to be used, and sends the request to participating railways

b) collates the data returned

c) publishes the average and range of performance to all those railways that have contributed data.

iii) <u>Ongoing revision of data</u>

Some railways consider that changing trends in performance will be more illuminating than "one off" exchanges.

It could be possible, ultimately, to agree a format that will enable a simple computer package to be used on a common basis.

It is suggested that more experience is gained of the data so far exchanged, and the possibility reviewed at the next seminar.

Recommendations

1. Further railways are invited to exchange data on the topics already originated by the western European group.

2. **Administration - collation, analysis, publication to participants -** is undertaken by Railway requesting the topic.

3. To respect confidentiality, only data averages and ranges are published, without the consent of individual railways concerned. Requests for identification of "Best Practice" railway can be forwarded by the administrating railway.

The International Railway Safety Seminar is asked to advise on the best way to progress this initiative.

D J Maidment, British Rail
M Joing, SNCF

October 1993

ANGER52.FMD

SAFETY DATA EXCHANGE / ECHANGE DE DONNEES DE SECURITE
****

ACCIDENTS AT LEVEL-CROSSINGS
ACCIDENTS DE PASSAGES A NIVEAU

COMPANY SOCIETE	P.N.Garde Protected L.C.		P.N.Automatique avec barrieres Automatic L.C. with barriers		P.N.Automatique avec feux Automatic L.C. with lights		P.N sans feux Open crossing		TOTAL		PIETONS PEDESTRIANS	TRAFFIC	CAR FLEET
	Accid.	Morts	Accid.	Morts	Accid.	Morts	Accid.	Morts	Accid.	Morts	Morts	millions km.Trains	millions cars
N°1	16.07	1.92	159.50	39.35	4.29	0.93	62.28	9.71	242.14	51.91	25.57	485	29.10
N°2	0.50	0.00	35.00	9.50	24.00	2.50	8.00	0.50	67.50	12.50	Inclus	96	4.45
N°3	19.67	0.83	15.58	3.83	2.25	0.92	29.50	7.25	67.00	12.83	Inclus	425	24.50
N°4	0.00	0.00	35.67	14.17	65.33	30.50	5.83	2.17	106.83	46.83	Inclus	115	
N 5	0.00	0.00	5.00	2.50	4.50	1.00	28.00	4.50	37.50	8.00	Inclus	123	4.20

SAFETY DATA EXCHANGE / ECHANGE DE DONNEES DE SECURITE

Severe accidents caused by Signals Passed At Danger
Accidents mortels consécutifs à des Franchissements de Signaux d'Arret

ANNUAL FREQUENCIES

COMPANY SOCIETE	FREQUENCY Rattrapages Rear end	FREQUENCY Nez à nez Head on	FREQUENCY Convergences Side	FREQUENCY TOTAL	MORTS/AN FATAL/YEAR	TRAFIC TRAFFIC Millions Tr.Km
N°1	0.11	0.19	0.11	0.42	2.08	480.00
N°2	0.20	0.03	0.00	0.23	0.97	96.00
N°3	0.00	0.15	0.15	0.31	1.08	123.00
N°4	0.24	0.16	0.16	0.56	1.68	425.00
N°5	0.13	0.13	0.06	0.31	4.31	115.00

SAFETY DATA EXCHANGE / ECHANGE DE DONNEES DE SECURITE

Fatalities and injuries to employees working on the track hit by rolling stock
Accidents du travail aux agents travaillant sur les voies heurtés par une circulation

COMPANY SOCIETE	TRACK MAINTENANCE AGENTS DE LA VOIE	SIGNAL MAINTENANCE AGENTS SIGNALISATION	OVERHEAD LINE MAINT. AGENTS CATENAIRES	SHUNTERS AGENTS DE MANOEUVRE
	Probabilité annuelle individuelle de décès	Probabilité annuelle individuelle de décès	Probabilité annuelle individuelle de décès	Probabilité annuelle individuelle de décès
MINIMUM	0.99E-4	0.50E-4	1.10E-4	2.42E-4
MAXIMUM	3.68E-4	1.52E-4	5.00E-4	4.20E-4
AVERAGE	2.64E-4	0.97E-4	3.05E-4	3.50E-4

SAFETY DATA EXCHANGE / ECHANGE DE DONNEES DE SECURITE
****

Fatalities and injuries to passengers falling from trains
Accidents de personnes par chutes de trains
CHIFFRES PONDERES PAR MILLIONS DE VOYAGES

Company Societé	FALL WHEN JOINING THE TRAIN CHUTE A LA MONTEE				FALL EN ROUTE CHUTE EN ROUTE				FALL WHEN ALIGHTING CHUTE A LA DESCENTE			
	Passengers/voyageurs		Other /autres person.		Passengers/voyageurs		Other /autres person.		Passengers/voyageurs		Other /autres person.	
	Fatalities Morts	Injuries Blessés	Fatalities Morts	Injuries Blessés	Fatalities Morts	Injuries Blessés	Fatalities Morts	Injuries Blessés	Fatalities Morts	Injuries Blessés	Fatalities Morts	Injuries Blessés
MINIMUM	0.0020	0.0092	0.0000	0.0000	0.0037	0.0000	0.0000	0.0000	0.0000	0.0148	0.0000	0.0000
MAXIMUM	0.0110	0.0405	0.0018	0.0066	0.0230	0.0135	0.0036	0.0030	0.0074	0.0774	0.0048	0.0138
AVERAGE	0.0056	0.0240	0.0008	0.0030	0.0134	0.0079	0.0016	0.0014	0.0044	0.0265	0.0022	0.0063

International Rail Safety Conference

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9328

Francois Pinton

Transport of hazardous substances General risk assessment on SNCF network

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

TRANSPORT OF HAZARDOUS SUBSTANCES : GENERAL RISK ASSESSMENT ON SNCF NETWORK

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Operation Expert
Safety Studies Center
SNCF

SNCF
Délégation générale
à la Sécurité
C.E.S.

Transport of hazardous substances
General risk assement on SNCF network

by François PINTON
Opération expert
Safety Studies Center

On SNCF, the transport of hazardous substances accounts for 15% of freight shipments per year. This activity poses risks to the environment and has a major impact on the company's image.

SNCF has conducted an overall evaluation of transport-related risks but prior to explaining the methodology applied, we should first give a few background information.

1. Recent accidents on the SNCF network

In the latest period, SNCF experienced several accidents involving hazardous substances :

- at Chavanay, on December 3, 1990, where a train made of 22 tank-wagons loaded with lead-free supergasoline was derailed on the running line while travelling through an urban area. The condition of the track is meant to be the reason for the derailment of the first tank-wagon. A fire broke out immediately, destroyed a house, a petrol-station and several lorries which were in the vicinity of the railway. Fire also affected nine tank-wagons loaded with supergasoline. The facilities were broadly reconditioned after nine days'work.

- at Aix-les -Bains, on March 16, 1992, where a freight train carrying various commodities was derailed when approaching the station. It is likely that an empty hopper-wagon for the carriage of grain was the first to be derailed and caused the derailment of another six wagons. An empty non-degasified tanker for dimethylamine and a wagon containing dimethylcetone caught fire which propagated to an ammonia-filled tanker. The disaster could be kept under control owing to the response of the fire brigade.

Some 700 local residents had to be evacuated. The facilities were broadly reconditioned after five days'work.

- at la Voulte, on January 13, 1993, a train made of 20 tankers carrying lead-free supergasoline was derailed in an urban area. Five tankers caught fire which propagated to adjacent property, two explosions occurred and supergasoline was spilled in the local sewage system and pumping plant. The derailment is likely to be the result of some rolling stock failure.

Fortunately, there were no fatalities in connection with the above-mentioned accidents . However their occurrence was instrumental in making public opinion and the company's top management aware of the hazard risk from the transport of dangerous substances.

During the Chavannay and la Voulte accidents in particular, SNCF had to face immediately the damage caused by fire and to confront the polluting effect of hydrocarbon spillage in the ground. The company was thus compelled to face the complex pollution control operations and to incur the resultant costs.

2. Major hazard risks now part of SNCF's safety strategy

Major hazard risks are now fully taken into consideration by the company, which can be exemplified by recent initiatives such as :

2.1. The setting-up of CSMD
(Safety Committee on Dangerous Substances).

In the second quarter of 1992, SNCF headquarters decided to set up a high-level committee, chaired by the Director in charge of infrastructure management. At the planning and enforcement stages, this committee works in conjunction with engineering and operating services (operations, design and maintenance of fixed works and traction & rolling stock) and the freight business sector (development of services, marketing, liaising with the relevant ministries)

It was given the following remit :
- to investigate into major incidents or accidents during the transport of hazardous substances,
- to reflect upon such events in order to prevent them,
- to recommend quantified risk analysis and take any decision in this respect.

2.2. The launching of a prospective research study

At its first meeting, the Safety Committee on Dangerous Substances decided to conduct a wide-ranging study of hazard risks from the transport of dangerous substances by rail.
The study was initiated in September 1992 and final conclusions are expected for the end of 1993.

SNCF has called upon two consulting firms for this study :
- SECTOR : independent consulting firm specialized in risk and complex-system management,

- INERIS : a large organization in charge of studies and tests falling under the Ministries for the Environment and for Industry and providing consulting services.

3. Outline of the study

3.1 The approach

The approach is threefold :

- an overall risk assessment study : unlike studies conducted on specific products such as chlorine or LPG, the study encompasses all hazards and consequently all products,

- a quantified risk assessment study : Probability calculations have enabled us to produce an overall risk-picture, to compare the frequency of such events but this process did not go as far as working toward the attainment of specific safety objectives.

- a study on the strength of recipients : The transport of dangerous substances by rail is based upon the safe running of freight trains and on the characteristics of recipients. Standards governing the construction of tankers are quite stringent and vary according to the commodity carried.

3.2 Three phases

The study is implemented in three phases :

- review of traffic-patterns, classification of products and recipients,

- review of critical events, evaluation of their possible occurrence and of their consequences.

- risk analysis conducted on actual cases:
Three sites were selected : two large marshalling yards and a medium-sized station . Two sections of route were selected . They are located respectively between Paris and Normandy and along the Rhône valley in the Lyon area. Fixed sites and sections of route were carefully selected in order to cover the widest range possible of environmental situations.

4. Traffic pattern analysis and classification of products and wagons

Dangerous substances is a generic term used for a wide range of products such as : fuels and spirits, chemicals and also garbage or melting metal under controlled temperature. This does not include such products as detergents or certain categories of fertilizers which may give rise to major pollution problems following the loss of containment.

The study reviewed all products carried by rail, the existing nomenclatures and identified traffic-flows in connection with each item.

Then, on the basis of a nomenclature used for quoting freight transport prices, products were analysed and combined into classes as long as they were homogeneous with regard to the hazard under consideration. A typical product was then selected within each class.

The same classification exercize took place for tank-wagons carrying dangerous goods. Without expanding upon the detailed technical features prescribed by the relevant regulations according to the commodity, seven main tanker-categories could be identified :

Appendix 1 sets out the agreed classes.

5. Definition of critical events, evaluation of their possible occurrences and consequences

5.1. The definition of critical events

From the outset, the seven major risks which will be referred to as "critical events", were established :

- BLEVE : boiling liquid expanding vapour explosion

- UVCE : unconfined vapour cloud explosion

- Toxic releases : a large volume of toxic gas is released in the air

- Pollution of ground

- Pollution of water

- Explosion : this applies to the explosion of pyrotechnic substances or military ammunition whereas UVCE is mainly a problem with LPG.

Appendix 2 summarizes the critical events in connection with every class.

5.2. The probability calculations

The possible occurrence of each critical event is based on the analysis of accident-data :

This study provided us with the opportunity of compiling numerous incident or accident records : thus three main data-bases were set up :

- a review of derailments involving dangerous goods over 17 years (117 events)

- a comprehensive review of derailments of freight trains during transit, over 10 years (110 events)

- a survey on shunting incidents in various facilities : marshalling yard, medium-sized station, intermodal traffic terminal, staging yard, dock railway (245 events).

Quantification principles are illustrated with trees in Appendix 3.

5.3. The evaluation of effects

The effects of each critical event are evaluated on the basis of models which are of standard use in the chemical and oil industries for hazard analysis purposes.

Then assumptions were taken as to :

- the typical environmental conditions (weather conditions, local topography)

- the typical conditions for loss of containment (size of gaps, loading conditions).

The study gives, for each event, the lethal radius with regard to :

- the concentration of toxic gas in the air,

- the shock-wave following an explosion,

- thermal radiation.

Consequently, the distance beyond which there is no risk of lethal effects can be determined.

6. Preliminary findings

6.1. The most critical hazards

The most critical hazards posed by shipments are the following:

- the transport of hydrocarbons on the main line

- shunting movements applied to wagons carrying toxic products

6.2. The effectiveness of preventive measures

Furthermore, the study enabled us to measure the effectiveness of the preventive steps taken to lessen the rail risk associated with hazardous substances.

A number of assumptions could be tested i.e. :

- organizational measures with a view to reducing derailment-risks during shunting : they mainly have an influence on toxic-release risks,

- technical improvements on wagons carrying some products : they mainly have an influence on the risk of highly toxic releases from products during transit on the main line,

- major investment programmes to upgrade fixed works and railway tracks in the country : they have an influence on fire-risks generated by derailments.

The study has fulfilled one of the remits . It has provided guidelines and recommendations to SNCF's top management in terms of safety-related investment strategy.

October, 1993

Appendix 1 Classes agreed for the study

Contents	Recipient	traffic
matières explosives	covered wagon	0.2%
chlorure de vinyle	tank wagon B	1.9%
butadiène	tank wagon B	3.8%
butane	tank wagon B	2.3%
propane	tank wagon B'	9.2%
chlorure de méthyle	tank wagon B	3.3%
supercarburant	tank wagon A	14.6%
gaz oil	tank wagon A	11.7%
vide de supercarburant	tank wagon A	14.6%
vinylbenzène (styrène)	tank wagon C	0.8%
alcool éthylique	tank wagon A	2.2%
engrais azotés	hopper wagon	1.5%
souffre	tank wagon D	2.7%
eau oxygénée	tank wagon C	0.3%
nitrate d'ammonium	flat sheeted wagon	3.8%
cyanure de sodium	tank wagon F	0.5%
chlore	tank wagon E	0.9%
ammoniac	tank wagon B'	3.6%
acide fluorhydrique	tank wagon F	0.1%
soude caustique	tank wagon C	6.4%
engrais phosphatés	tank wagon A	0.9%
chorure de potassium	high sided open goods wagon	13.9%

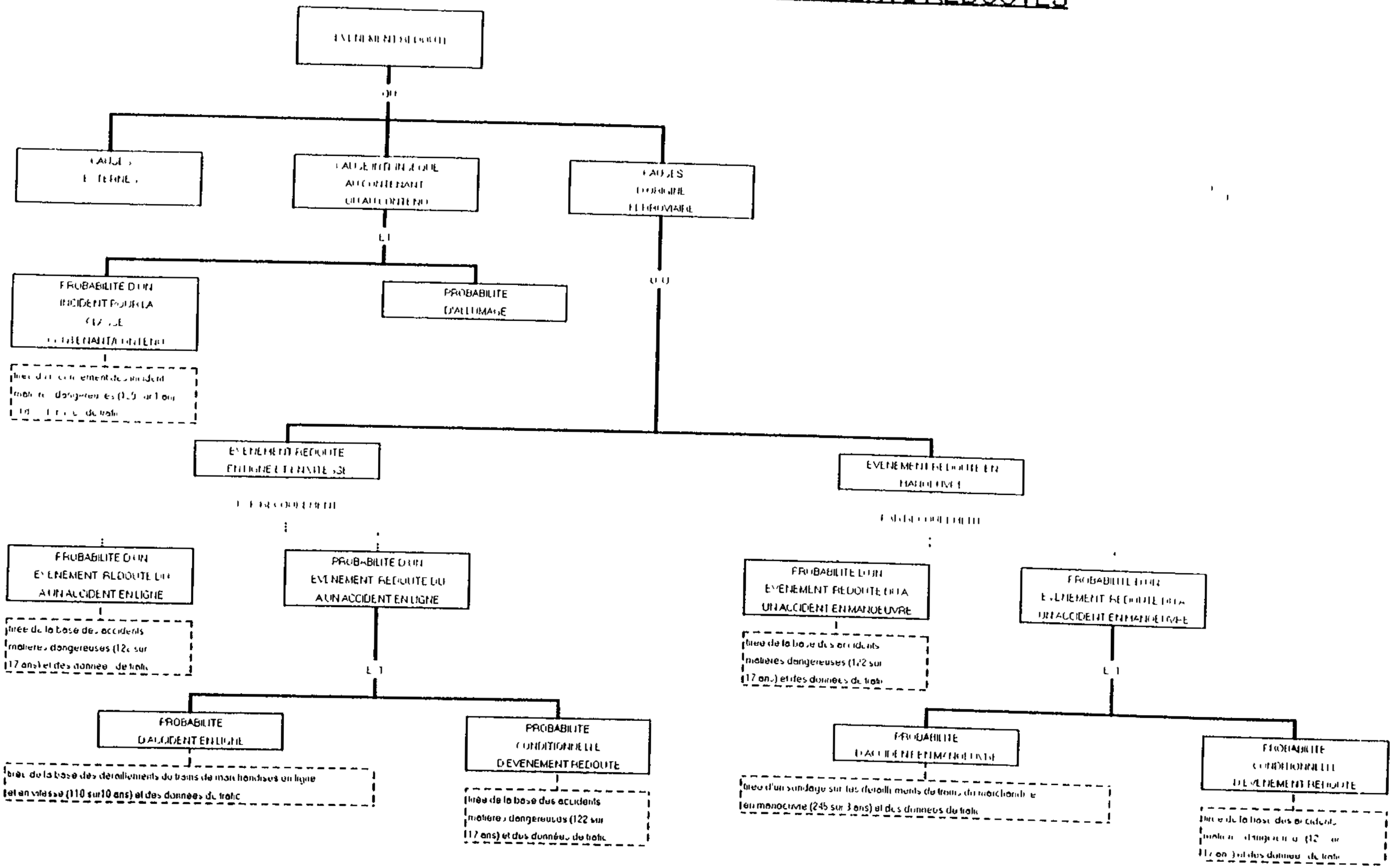
Seven main tank-wagon categories have been identified

Appendix 2 Critical events for each classe

Contents	bleve	uvce	toxic	pol g	pol w	fire	explo
matières explosives							x
chlorure de vinyle	x	x	x			x	
butadiène	x	x					
butane	x	x				x	
propane	x	x				x	
chlorure de méthyle	x	x				x	
supercarburant	x	x		x	x	x	
gaz oil				x	x	x	
vide de supercarburant							x
vinylbenzène (styrène)				x	x	x	
alcool éthylique	x	x				x	
engrais azotés				x	x	x	
souffre				x	x		
eau oxygénée				x	x		
nitrate d'ammonium				x	x	x	
cyanure de sodium			x	x	x		
chlore	x		x	x			
ammoniac	x		x	x			
acide fluorhydrique	x		x	x	x		
soude caustique				x	x		
engrais phosphatés				x	x		
chorure de potassium				x	x		

Appendix 3

PRINCIPE DE CHIFFRAGE DES EVENEMENTS REDOUTES



JLT/PRINCIPE XLS/11/10/1993

International Rail Safety Conference

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9329

Francois Laporte

Emergency measures plan - Saint Leonard d' Aston: A story of communication and cooperation

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

EMERGENCY MEASURES PLAN SAINT-LEONARD D'ASTON : A STORY OF COMMUNICATION AND COOPERATION

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Canada National

ST. LEONARD D'ASTON...

A story of communication and cooperation

1. The following slide presentation will discuss the accident and the emergency measures that were implemented at St. Leonard d'Aston.

2. First, here are some basic details. At 10:45 am, train 429 with 5 locomotives & 92 cars travelling from Charny to Montreal derailed 33 cars at St.Léonard d'Aston at mile 80.17 on the Drummondville subdivision. 15 of these cars contained dangerous commodities such a sodium hydroxide, used lubricating oil, styrene monomer and chlorine.

3. St. Leonard d' Aston is a small town with about 2, 100 residents. It is located about 20 km northeast of Drummondville, Quebec. The Nicolet River lies near the southwest end of town.

4. This is an aerial view of the accident. The local fire station and the Local Centrer of Community Services were near the accident site. The derailed cars were spread along 150 metres of track in a gigantic 12-metre high pile-up. A local newspaper described the scene as being " as high as the Quebec Hydro electrical lines."

5. There were about 10 houses near the area of the accident site. Two of them were damaged, but fortunately no one was hurt. Since the accident occurred in the morning, most of the residents were either at work or at school rather than in their homes.

6. This house was surrounded by cars that jumped the tracks. An ATCO mobile unit was being used by Bridges & Structures employees only ten minutes before the accident. It was crushed under the derailed cars. The GO team inspectors discovered a propane leak from the unit. Corrective measures were taken immediately so there was no danger of fire. If you look closely you can see a motor home squashed under the hopper car.

7. This is a list of the contents of the 33 derailed cars. The four cars of chlorine were potentially the most dangerous. These cars had to be handled with extreme care. The cranes on site lifted the cars of chlorine and styrene monomer without difficulty.

However the car of used lubricating oil did cause some problems. It was leaking and 10,000 gallons of oil had to be recovered from the ground. All eight cars of sodium hydroxide, also known as caustic soda, were perforated. Only 32,000 gallons out of a total load of 89, 000 gallons were recovered. Of the remaining 57,000 gallons, an indefinite amount leaked towards the river and the rest was absorbed by the ground.

More than 5,000 cubic metres of soil were contaminated by the caustic soda. Experts estimated that it would cost about 2.5 million dollars to neutralize the soil on the site. Such a procedure would entail environmental risks.
Together with Environment Canada and Environment Quebec, the decision was made to transport the contaminated soil to Taschereau Yard for processing. This proved to be the best solution and the most economical. The total cost was less than 750,000 dollars.

8. Let's take a chronological look at the events as they happened.

-- At **10:45** the train conductor advises the dispatcher of the accident.

-- At **10:46** the assistant chief and chief dispatcher are advised of the situation.

-- At **10:48** R.O.C.O. is informed and sets the alert plan in motion.

-- At **10:49** the chief dispatcher calls the train conductor for more information.

-- At **10:52** the chief dispatcher informs the Quebec Provincial Police of the derailment explaining that dangerous commodities such as chlorine are involved.

9. At **10:55** the district manager activates the district emergency plan.

--**By 11:00**, just 15 minutes after the accident occurred, all the members of the crisis management team have been alerted and are preparing for action. The various divisions involved in this process are: Telecommunications, Engineering, Transportation, Safety and Loss Control, Environment, Equipment, Public Affairs and CN Police.

--**At 11:15**, the QPP arrive on the scene. They notice a cloud of smoke rising from the accident site. They believed it was caused by a chlorine leak and proceeded to evacuate the surrounding area. This affected about 125 persons, many of them from a nearby senior citizen's home. Later, it was learned that no chlorine leak existed. The cloud of smoke was probably caused by a chemical reaction between the aluminium and the caustic soda.

10. **By 11:45** the trainmaster is on the site. His work included verifying documentation, evaluating the situation, reporting to the chief controller and R.O.C.O. and meeting with the chief fireman.

--**At 13:05**, the district manager is evaluating the situation on the site.

11- An imposing array of equipment was sent to St. Leonard d'Aston.

-- **By 13:10**, mobile 3 arrives from Taschereau Yard. This is an important resource for the technicians who immediately begin to search for leaks coming from the derailed cars.

-- **At 13:15** two specially equipped mobile units are available to CN's team. A mobile home housing several communications facilities serves as the command post. It is staffed around the clock to ensure constant communication. The other unit, an ATCO, is used as a conference room.

-- **At 13:20** a 100-metre safety perimeter is established.

12- **By 13:30** CN crews begin to clear the derailed cars from the tracks. With the help of specialized companies like Sanivan, Sani-Mobile and Servac, the crews start to collect pollutants.

-- **At 13:35** a major coordination plan for the sight is established and every team member is reminded of his responsibilities.

-- **At 13:45**, the district manager and the Public Affairs manager meet the mayor, civil protection director and other intervening parties. This set the pace to establish rapport among all the parties involved.

13. This is a diagram of the various parties that made up the crisis management team.

-- The site manager's main responsibilities were to establish a global plan of action and supervise all operations.

-- The assistant site manager operated the command post and kept an operation register.

-- The role of the Public Affairs manager was to act as the official spokesperson with the media, government authorities, local representatives, community leaders, accident victims and official organizations. He also organized the media's visits to the site.

-- Intervening parties such as Environment Canada, Environment Quebec, The American Railways Association, Transport Canada and chemical industry representatives made a significant contribution to our success because of their experience and expertise.

-- The role of CN's Safety and Environment officers was to ensure the population's and employees health and safety, protect the environment and decide on the most effective decontamination methods.

-- The role of the Transportation officer was to coordinate the train movements.

-- The GO team, which is part of the Equipment department, was responsible for checking for leaks and declaring the site safe for the workers. The other Equipment department team members lifted the cars and cleared the site.

-- Engineering reconstructed the tracks and restored the signal system.

-- General Claims was there to minimize the economic consequences of the accident while settling claims in an equitable manner.

-- The CN Police was responsible for traffic control, public surveillance and protecting life and property.

14- Here we see one of the severely damaged, leaking sodium hydroxide cars. Sodium hydroxide is corrosive and dangerous if it comes into contact with skin and eyes. Personnel handling this chemical wore protective clothing, safety glasses and rubber boots.

15- Here we see the location of the mobile homes that served as the command post and the conference room. The red circle around the impact point represents the established 100-metre safety perimeter.

16- Another safety perimeter was established during the most critical portion of the work: the lifting of the chlorine cars on December 14. The safety perimeter required an evacuation involving 800 persons. When the winds changed direction, an additional 200 persons were affected.

We also see the location of the field-hospital set up in the fire station and the town hall. This emergency facility, provided by OSMOCO, included showers, beds and cardiac resuscitation equipment etc. You also see a solid blue line representing the evacuated 800 meter perimeter.

17- To inform and reassure the population, several meetings were organized by the regional manager-Public Affairs and the site managers.

The public authorities were informed daily on the progress of the work. One information session was also organized each day for the media and the general population.

18- The participants in the two daily on site meetings were Transportation, Car Equipment, Engineering, Public Affairs, General Claims, CN Police and Transport Canada, city leaders, Environment, Safety & Loss Control.

The objectives of these meetings were to define an intervention strategy, to establish a work plan and to ensure consultation and feedback.

19- This is the photograph that accompanied the front page story about the derailment in the local Le Nouvelliste newspaper.

20 - One of the stories carried by the paper explained how some Spanish observers (equivalent to Protection Civile) were very impressed by the crisis intervention and clean-up process on the derailment site.

21 - The City of St.Leonard d'Aston issued this invitation to a community celebration after the derailment for all the volonteers on Feb. 10.

A meeting of all parties involved in the re-establishment of the normal situation also took place in St. Leonard d'Aston on Feb. 16.

This debriefing exercise permitted a step by step analysis of the operations development and put in evidence the strong points and weaknesses of our emergency measures plan.

22 - To round out this presentation, we go back to the source. Although it is still under investigation, it is believed that this broken piece of rail caused the accident.

The broken rail was put new in 1974 and manucfatured by Sysco. 19 days before the derailment it had been inspected by a Dapco Ultra Sonic inspection vehicle. There was no defect found at the derailment location. However it had detected defects in the rail at another insulated joint located on the opposite rail some 500 ft east of the derailment.

23 - (Conclusion)

There were several factors involved in the crisis management operation at St.Leonard d'Aston. Perhaps the most notable factor was communication. In meetings with town leaders and media organized by CN Public Affairs, the district manager's assurances that the situation was fully under control helped to establish CN's credibility. The daily meetings held with all intervening parties ensured that they were kept abreast of the plans of action and constant realization of those plans. The communications hardware such as cellular phones, a fax machine and portable radios lead to an all-around smooth operation at St. Leonard d'Aston.

■ EMERGENCY MEASURES PLAN

Planning Methodology

- Compliance with Legislation
- Risk Analysis
- Control Methods
- Plan Draft
- Harmonization
- Training Program
- Simulation Exercise

■ EMERGENCY MEASURES PLAN

Risk Analysis

- **Determine Weaknesses**
  - historical study
  - qualitative study
  - determine probabilities

- **Analyze Failure Modes**
  - preliminary risk/cause analysis
  - failure mode analysis
    - » effects
    - » criticality

■ EMERGENCY MEASURES PLAN

Control Methods

● **Facilities Map**

- standardization of symbols
  - » National Fire Protection Association
- emergency response equipment
  - » HAZMAT
  - » extinction
  - » extraction
- aerial photos
- area maps
  - » geomatics
- Dispersion Software Analyzer

■ EMERGENCY MEASURES PLAN

Control Methods

● **PAPER OR COMPUTER SIMULATIONS**

- view the evacuation procedure
- establish access routes
- evaluate response methods
- evaluate resource requirements
- analyze response time
- analyze ecological problems
- analyze the environment (other risks)
- develop response and control strategy

■ EMERGENCY MEASURES PLAN

Control Methods

● TELECOMMUNICATIONS PLAN

- telephone lines
- fax machines
- two-way radios
- CBs
- pagers
- etc.

■ EMERGENCY MEASURES PLAN

Plan Draft

● DEFINE RESPONSIBILITIES

- organization chart
- responders' responsibilities
  - » internal
    - ● coordinator
    - ● team leaders
    - ● team members
    - ● personnel
    - ● public relations
  - » external
    - ● forest fire fighters
    - ● police officers
    - ● ambulance attendants
    - ● outside firms
    - ● etc.

■ EMERGENCY MEASURES PLAN

Plan Draft

- **EMERGENCY PROCEDURES**
  - fire
  - spills
  - injuries
  - bomb threats
  - etc.

- **ALERT PLAN**
  - alert procedure flowchart
  - telephone directory

- **PREVENTIVE MEASURES**

■ EMERGENCY MEASURES PLAN

Harmonization

- **Present the plan to the various responders involved**
  - Study sessions to integrate the various response plans
  - Adjust plan as required
- **Establish a specific response plan**
- **Harmonize plan with external responders' plans**

■ EMERGENCY MEASURES PLAN

Training Program

- **Management**
  - Employees
  - Emergency response teams
- **Simulation exercise**
  - Internal
  - With various responders

EMERGENCY MEASURES PLAN

Conclusion

- **Emergency Measures Planning**
    - A step in the risk prevention process

- **Risks could be from various sources:**
    - Personal injuries
    - Social conflict
    - Fire
    - Explosion
    - Toxic spills
    - Natural disaster

International Rail Safety Conference

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9330

Paul Abbott

Transport of hazardous substances Health and Safety sub-committee, A British Rail View

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

TRANSPORT OF DANGEROUS SUBSTANCES : HEALTH AND SAFETY SUB COMMITTEE REPORT. A BRITISH RAIL VIEW

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INTERNATIONAL RAILWAY SAFETY SEMINAR, OCTOBER 1993

RESPONSE TO THE HEALTH & SAFETY EXECUTIVE ADVISORY COMMITTEE ON DANGEROUS SUBSTANCES SUB COMMITTEE REPORT - A BRITISH RAIL VIEW.

Paul Abbott

British Rail HQ

1. INTRODUCTION

The work of the ACDS Sub Committee complements the British Railways Board commitment to running a safe railway. The Board has a continuous programme of improvement in safety performance. Full support was given to the Sub Committee's work to help ensure an accurate and meaningful outcome to the 5 year study. This paper addresses some of the issues involved and the recommendations relating to rail transport.

2. MANAGEMENT OF SAFETY

Whilst the Report concludes that the most significant risks studied are tolerable but not negligible it also emphasises the key role of management in ensuring safety in transport - as indeed in the workplace generally The implication for risks to increase if standards of safety management fall is well recognised by British Rail.

At the same time it is essential that changes in safety requirements consider carefully and objectively the cost effectiveness of what is proposed against the inherent risk. The Board has set a range of strategic Safety Objectives for 1993/4. These cover the whole operational range within British Rail of which the carriage of hazardous substances is but one specialised part. The work of the Sub Committee covered a specialised area but it is important that the safety process addresses reasons for actual and potential non conformance whether or not hazardous substances are directly involved.

3. USE OF QUANTIFIED RISK ASSESSMENT (QRA)

At the time the Sub Committee's work began historical incident data was widely used as a means of considering how improvements might be made in areas such as wagon design, railway operating rules and regulations. As we will see later, further improvements to the incident database remain important.

However British Rail was already looking at the application of QRA as an aid to the management of safety and had engaged consultants to consider how this might best be done. The implications of alternative routings of a specified flow of Liquefied Petroleum Gas were considered taking account of lineside population (1). A further QRA study reviewed the British Rail requirements for the formation of trains carrying hazardous substances - separation and compatibility (2). Again societal risks were considered. These studies, paralleling the work of the Sub Committee, gave us confidence in the application of QRA to transport. A further QRA study has also been undertaken to consider the risks at transfer terminals in changing from the use of conventional wagons to containers for the carriage of explosives. An extension of the Sub Committee work on petroleum transport has also been undertaken This is being followed up with work to reduce risks in the key areas of track, operation and wagon integrity. Generally the Board is now using QRA as a means of focusing management effort on key risks, for example on lines of rail route.

4. RAIL V ROAD

The Report concludes that "one cannot justifiably say that road is safer than rail or vice versa" nor is there justification "for legislation existing on a general transfer, on safety grounds, from road to rail or the reverse".

However in considering this general statement it is important that the detail of Appendix 11 of the report is studied carefully. There are uncertainties inherent in the study. For example the BR data includes actual petroleum incidents whereas generally that for the other reference hazardous substances studied (chlorine, ammonia and LPG) are based on engineering judgement. There has never been an event involving the breach of a liquefied gas tank on British Rail. Appendix 11 also points out that the transport of petroleum spirit - the single biggest tonnage of hazardous substances moved by rail - is estimated to be safer by rail than road with LPG broadly comparable. Both of these substances, indeed the majority of hazardous substances, have a relatively limited range in the event of an incident whereas the potential long range effect of a toxic gas release coupled with the historic routing of main rail lines through built-up areas indicates that the rail movement of toxic gases, in certain cases, is less safe than road.

The study emphasises the need to consider the detail of actual routes involved. Remember that neither rail nor road transport of hazardous materials present an intolerable level of risk. It is important that each mode is inherently safe, particularly with the spread of intermodal transport.

5. PRIVATE FACILITIES AND EQUIPMENT

5.1 TERMINAL FACILITIES

It should perhaps be pointed out that virtually all wagons carrying bulk hazardous substances are loaded and discharged in privately owned facilities. These facilities are often subject to statutory regulation such as the Control of Industrial Major Accident Hazard Regulations 1984.

British Rail has established arrangements, agreed with industry to ensure:-

- detailed BR input to the planning of new facilities.
- agreed operating arrangements to ensure safe access to the facility.
- wagons are offered to British Rail with valves, lids etc. safely secured; containment integrity is an essential input to safe carriage.

These arrangements require close liaison at local level between British Rail and the facility operator.

5.2 WAGONS AND CONTAINERS

With the exception of container carriers, most wagons carrying hazardous substances are also privately owned. Design, construction and maintenance are to standards set by British Rail, with industry involvement, to ensure fitness for purpose. Container wagons are generally owned by British Rail unlike most containers including those for hazardous substances which are privately owned. Standards requirements follow similar arrangements for wagon provision.

6. REPORT RECOMMENDATIONS

Few of the risks identified in the report are negligible. It is essential that the required standards are soundly based and audited to ensure compliance. Access to professional safety and specialist chemicals advice, together with skills training to give the appropriate competencies are essential to achievement of these standards.

The following considers the specific recommendations relating to rail.

6.1 WAGON DESIGN

The report suggests a detailed study of the design and construction requirement of tank wagons used for petroleum and ammonia. It must be appreciated that British Rail has had these standards documented for some years based on RID (3). They have developed through constant review in response, e.g., to feedback from accidents, from technological advancement, from industry and from the rail business need to remain competitive in the market place Specific designs are developed on the basis of these standards. The process of changes of a reasonably practicable nature to reduce risk is never ending. The "gross disproportion" principle identified in the report together with the not intolerable risk levels actually achieved has to be considered, there being little indication of any major areas where change is justified.

Equally important British Rail also has similarly developed and documented standards for the in service maintenance of wagons to ensure safe operation. Private wagon owners co-operate fully in the application of these requirements to their wagons. Increasingly in future internationally developed standards will have to be considered for inclusion in British Rail's requirements - again with the involvement of industry.

6.2 TRANSPORT OF EXPLOSIVES

The report makes a number of recommendations in relation to the rail transport of explosives. The study mentions the fact that British Rail is moving away from the use of conventional wagons towards the use of containers in response to market changes and pressures although the work did not extend to intermodal studies. The intermodal implications mean that changes to requirements for road transport of explosives will in many cases apply equally to rail. British Rail is keeping a close watch on a developments in container construction requirements in an area where purpose built equipment is often necessary.

Arrangements for weight limits of explosives during train formation have been in existence for many years. They were amended as recently as 1990 incorporating separation by Hazard Division maintaining British Rail's excellent safety record in transporting explosives. The HSE proposal for further separation into smaller net explosive tonnage groups would, with conventional wagons, be a much more inflexible and costly arrangement than is presently undertaken. At the same time the improvement in risk levels is likely to be small. Initial considerations suggest that with containers such an arrangement is more likely to be reasonably practicable.

Another benefit with the use of containers is that traditional shunting, already much reduced, will virtually disappear for explosives movements. A further benefit will be the reduction of risks associated with break-bulk loading of conventional wagons although different risks associated with container transfer have to be considered.

6.3 SPECIALIST DRIVERS

As mentioned in the Sub Committee's report the selection process for Drivers already ensures we choose staff of the appropriate standard. Organisationally, as individual Rail Businesses own particular product movements, British Rail is moving towards work specialisation on the part of train crews - and therefore the hazardous materials with which they are involved.

Probably the most important part of the competency required of train crews, within the rules and regulations involved, is the need to know how to respond safely and effectively when an incident or emergency occurs involving hazardous materials.

The extent to which the existing more general training content needs to be improved, perhaps to give more information on the dangerous goods being carried, is being examined with an eye on road driver training requirements. Already the on train information available to the train crew has been enhanced as an aid to knowledge both of the properties of the hazardous material and personal safety.

What is important, in addition to the operational safety requirements at an incident, is that prompt accurate advice is given to the Emergency Services both of the circumstances of an incident and the hazardous materials present. The means of emphasising the importance of this advice and getting the message across to train crews e.g. through the use of safety briefings, is being considered.

6.4 RESPIRATORY EQUIPMENT

The report recommendation needs much more study in terms of practicability and potential benefit - particularly on rail where a variety of hazardous substances may be carried on one train. Further discussion with the HSE is necessary, particularly in relation to use for safe emergency evacuation of the train crew from the site of an incident.

6.5 INFORMATION FROM SITE

Mention has already been made of the importance of accurate information being made promptly available from the site of an incident, this being an essential input to an effective emergency response.

British Rail has invested heavily in on-train radio systems available to the train crew and incorporating an emergency call facility. These enable a much quicker notification from site. Even if the train crew are incapacitated such that they cannot use this equipment, modern signalling means that lack of train movement or a problem will quickly become evident. Information of dangerous goods in wagons or containers on a train is held in the British Rail Total Operations Processing System (TOPS) which can be interrogated, giving information to Emergency Services even before they arrive on site.

Although satellite tracking systems are being considered, they would need considerable sophistication to give details of exact on site circumstances.

6.6 EMERGENCY RESPONSE

Clearly the priority is prevention but accidents will happen. British Rail is committed to having an effective liaison with the Emergency Services and a full joint understanding of roles and responsibilities particularly in relation to command and control at an incident or emergency. Forward planning is essential as is a detailed understanding by the Emergency Services of the British Rail safety procedures and equipment.

British Rail organise, with British Transport Police facilitation, table top command and control exercises in each county each year involving British Rail and the emergency agencies. The exercises are supplemented by BR assisting provision of scenarios and stock, with the involvement of industry for freight vehicles, for full size exercises.

These often involve dangerous goods scenarios and in some cases are specifically organised to test rail forwarders or commodity owners specialised support emergency plans.

It should be noted that for each occasion hazardous substances are carried, British Rail obtains from the product owner a specialist advice contact, available 24 hours, who can support the Emergency Services if necessary. Specialist assistance may be provided through the Chemical Industries Association's mutual aid CHEMSAFE scheme or industries specialist response arrangements such as "Ammonia Aid"

British Rail has also helped the National Fire Service College at Moreton-in-Marsh establish a rail training facility with locomotives, passenger and freight vehicles including various types of hazardous substance wagons and containers, also electrified lines and other railway equipment. Once again industry help has been readily forthcoming to assist in this important means of educating Emergency Services to potential problems associated with response to a rail incident.

In addition British Rail produces "lineside safety videos", hazardous substance information documents and leaflets which supplement the exercise and regular liaison between British Rail local managers and the Emergency Services.

A further development in emergency planning now involves the National Rivers Authority where British Rail is co-operating in ensuring an appropriate understanding and response arrangements to potential environmental pollution, possibly following a dangerous goods incident.

6.7 COLLECTION OF DATA

British Rail has systematically collected data on dangerous goods incidents, small or large, for many years. In the last 7 years this has been established as a database, more recently incorporating tonnage and mileage information. Details of "out of course" wagon repairs are also collected. In addition all incidents are now ranked according to potential hazard.

This information is shared with industry and used to target areas of perceived system weakness hence reducing associated risks to a minimum.

It is important in comparing this data internationally that the same definitions/criteria are used. Unless this is done the perception of customers/industry could be distorted.

7. THE FUTURE

7.1 DEVELOPMENT OF SUB COMMITTEE'S WORK

It is important, in following up the work of the ACDS Sub Committee and in improving the safe transport of hazardous substances that British Rail works closely with both the HSE and industry. It is necessary that we identify and concentrate on those aspects potentially most rewarding. Duplication of effort must be avoided - in all areas.

For example the aspects of dangerous goods transport not yet considered in detail during the Sub Committee's work will need to be taken forward, particularly intermodal systems and packaged goods. These are traffics very important to British Rail with the advent of the Channel Tunnel

7.2 HARMONISATION OF ACCEPTANCE AND CARRIAGE REQUIREMENTS

British Rail has, since the 19th Century, set out its requirements for the acceptance of dangerous goods nationally and applies RID to international movements. In addition it applies any specific statutory requirements to the carriage of dangerous goods.

BR already largely applies UN recommendations and in seeking harmonisation has for many years provided experts to support Government activity in the International forum. Before the privatisation process started BR had already agreed with the Health & Safety Executive (HSE) and Department of Transport (DOT) to work towards adoption of RID conditions for the acceptance and carriage of national movements of dangerous goods. As considerable road hauliers we also supported harmonisation of national road conditions with ADR (4). We also supported in due course the adoption of Regulations based on these requirements. These intentions recognised European Community aspirations and the opening of the Channel Tunnel. Now, as privatisation becomes a reality, the pace has quickened towards virtual harmonisation of road and rail conditions for both national and international movements. These changes will therefore achieve much that we have sought for years.

Privatisation timescales are working the rail dangerous goods regulations toward an implementation date of 1 January 1994. The date for modal harmonisation is 1 January 1995 and with this in mind it is intended that some aspects of the LDG acceptance requirements (5) will continue to apply until 1 January 1995. Clearly the new regulations will apply to all those using the rail network.

The carriage of Dangerous Goods by Rail Regulations (CDG Rail) will reflect Government acceptance of the recommendations contained in the HSE Report "Ensuring Safety on Britain's Railways" (6). This recommended that regulations should be prepared to provide sufficient statutory control of the carriage by rail of all dangerous goods. The proposed legislation places general duties on those involved in the rail carriage of dangerous goods. Aspects covered include the following:-

- information on dangerous goods intended for carriage.
- loading and unloading arrangements.
- safe movement requirements including on train segregation.
- wagon and container construction, testing, examination and maintenance.
- information availability on wagons/trains
- hazard placarding.
- emergency response arrangements.

Consideration and application of the requirements of CDG Rail must take account of complementary new regulations Classification, Packaging and Labelling of Dangerous Goods for Carriage by Road and Rail Regulations (CPLDGC), to be implemented on the same date. Specific requirements in the regulations will also reflect the particular risks associated with the carriage of explosives and radioactive materials already recognised in the BR Byelaws (for explosives) and the LDG.

It is essential with the detailed implementation of these Regulations that the transitional timescales are the same for both road and rail. Many rail movements are intermodal and the same transitional arrangements will assist clarity of the requirements - hence safety, minimise the cost of change and not disadvantage rail compared to other modes.

It is important to remember that the regime for the safe carriage of dangerous goods on the rail network will include:-

- mandatory BR Groups Standards
- other BR documents related to acceptance and movement requirements

These will provide a means of complying with the safety objectives in CDG Rail as well as the more specific requirements of CPLDGC.

The need and extent of any additional guidance/approved codes of practice will be determined by the impact of disaggregation of the railway, the future of the various BR documents and the interpretation of the Regulations by the enforcing authorities, especially HM Railway Inspectorate.

Much work remains to be done in a very short timescale, now that the consultation period is ending, to ensure that the detail in the Regulations is properly developed. Although some preliminary work has been done, only when this detail is known can changes to the BR acceptance and operatir : arrangements be fully considered and implementation planned. For example we need to be sure that there is a clear understanding of responsibilities throughout the transport chain and that the duties placed on the operator are reasonable

The regulations being developed recognise the need for the continuation of effective management controls to ensure the standard of safety already achieved in the carriage of dangerous goods is maintained or improved in the future. In so doing the regulations support the recommendations of HSE ACDS report. We are also working towards harmonisation of British Rail requirements with UIC (7) recommendations.

7.3 ENVIRONMENT

Environmental issues did not form part of the Sub Committee's remit. However mention has already been made of the British Rail work with the National Rivers Authority. Increasingly pressures to ensure preventation of environmental pollution also relate to the Emergency Services understanding of a situation they may be facing and their response. British Rail can help in ensuring accurate information from the site of an incident or emergency. In addition of course the environmental concerns raised by the carriage of hazardous substances is a particular concern of the European Community.

7.4 EUROPEAN COMMUNITY DEVELOPMENTS

The need to keep very close to EC developments is vital for British Rail particularly as these developments properly seek to ensure greater harmonisation of community state legislation as means of carrying dangerous goods, safely and economically, with minimum risk to people and the environment.

Equally it is important that the EC has an effective means of taking account of the rail carriers views and potential problems. There are a number of areas of impending development such as :-

(1) Risk Prevention Officer.

Draft Directive on the appointment and vocational qualification of an officer for the prevention of risks inherent in the carriage of hazardous substances. Transport undertakings, including British Rail, will need to ensure the detail of this Directive is developed to sensibly take account of the many concerns being expressed.

(2) Post Seveso Directive.

As originally drafted this incorporated proposals potentially difficult for rail transport to manage e g. in - transit stoppages, yet without clear benefits having been identified. Again there is a need to very closely watch any emerging proposals.

(3) Harmonisation of Conditions

The emerging directives requiring harmonisation of Domestic Carriage Requirements with RID ADR. Although the new UK Regulations for national movements will more closely reflect International requirements from 1 January 1995, once again the detailed implications would need to be watched very closely.

8. SAFETY

This presentation has addressed the arrangements for the safe carriage of dangerous goods by rail in response to the HSE Report as well as areas of change - necessarily briefly. This is indeed a time of rapid change in requirements for the safe carriage of dangerous goods. The UK Rail privatisation process is paralleled by essential harmonisation and development of Regulations aimed at ensuring continuing safe rail arrangements in the future. As already mentioned at the same time the European Community is also taking an increasing interest in this area.

It will be a challenging task to ensure that these changes and their implications are properly co-ordinated and clearly understood by all those involved in ensuring the safe carriage of dangerous goods by rail such that despite the many potential distractions the maintenance of safe operation and keeping the railway running for the customer continues.

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(5) List of Dangerous Goods (LDG) and Conditions of Acceptance by Rail on Freight Services and Parcels Services BR22426 1990

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(7) International Union of Railways (UIC).

International Rail Safety Conference

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9331

David Rayner

Evaluation of ATP Benefits

Note: This paper was basically a verbal presentation, accordingly as such there is no written paper.

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

EVALUATION OF ATP BENEFITS

David RAYNER

Board Member
British Railways Board

International Rail Safety Conference

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9332

Bruno Cozzi

The implications of ATP system on SNCF network

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

THE IMPLEMENTATION OF ATP SYSTEM ON SNCF NETWORK

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The Implementation of the KVB (ATP) System on the SNCF Network

by Mr Bruno COZZI, SNCF's Safety Delegation

Enhancing safety of operations has always been one of the prime objectives of railway companies. The achievement of such an objective requires constant progress to be made in terms of regulations & procedures, training and practice of personnel as well as technical resources.

The graph given in Appendix 1 shows the trend, during the last 50 years, in the number of casualties per billion passenger-kilometers on the SNCF network.

The overall trend is quite encouraging although it has proved quite difficult to make significant improvements during recent years because of the high safety-performance level already achieved on the one hand and the speed-increases and concentration of traffic-flows on the main routes on the other.

1) Analysis of railway-related risks

We have conducted a comprehensive review over the last 35 years of such series of events that are likely to lead to fatal accidents and have been able to identify thirteen accident-scenarios. In each scenario, we have accounted for the mean severity expressed as the number of people killed on the train and the frequency of occurrence (i.e. counting the accidents falling in this scenario, divided by the length of the relevant period). See Appendix 2.

The risk pertaining to each scenario is given by the product of F (frequency) by S (mean severity). The graph below illustrates the relative position of each scenario against a network of constant-risk curves.

It can be seen that accidents due to signals passed at danger or overspeed (scenario 1) represent the highest risk involving 20% of serious accidents with fatalities and 25% of fatalities.

Considering the high risk and the unsatisfactory increase in the number of signals passed at danger in recent years, SNCF decided to start implementing an additional safety barrier on its conventional lines : i.e. the automatic train protection system known as "contrôle de vitesse par balises" (KVB).

2) Contrôle de vitesse par balises / KVB

2.1) Objectives

The purpose of the KVB system is to guarantee that trains will stop on the approach side of stop-signals and will comply with permanent or temporary speed-restrictions.

Such a system should leave the driver with the responsibility of complying with lineside signalling indications and should not affect driver behaviour provided that such remains compatible with safety rules.

However, the system has to act automatically when the driver does not comply with the requirement to stop or slow down, once cautioned.

2.2) Technical developments

The system selected was originally derived from a Swedish beacon-based permanent ATP with intermittent transmission and has been thoroughly modified to meet SNCF's specifications.

The system is based upon :

- beacons located in the vicinity to each equipped signal (see appendix 3),

- an antenna, a calculator and a unit in each cabin of the traction unit (see appendix 4),

When the driver passes a distant signal on, the calculator generates an alert curve and a train protection curve depending on the distance to the execution signal and the braking efficiency of the train.

The train protection curve reflects the maximum speed to be followed to comply with the signal for which the driver has been cautioned. If the alert curve is crossed, an audible warning can be heard in the cab. If the train-protection curve is reached, an emergency braking sequence is triggered until the train comes to a stop (see appendix 5).

3) Predicting system efficiency

3.1) ATP installation principles

Recent railway accidents have shown that the main danger-area lies at converging lines.

In order to optimize the efficiency/cost ratio of the project, SNCF has opted for a non-continuous implementation of ATP and has equipped stop (and advance) signals on the approach side of converging lines.

3.2) Predicted efficiency

The assessment of an optimized ATP system efficiency was based upon a statistical analysis of the 1987 and 1989 figures for stop signal overrun and in conjunction with three line equipment assumptions :

. scenario A - 2,300 signals and 3,600 motive power units

. scenario B - 3,800 signals and 3,600 motive power units

. scenario C - all signals and 5,000 motive units (i.e. all main-line traction units).

With scenarios A and B, the number of instances of signal overrun can be reduced by 36% and 45% respectively.

Scenario C involves equipping all stop signals and main-line traction units and should prevent 88% of signal overruns.

These results are summarized in Appendix 6.

3.3) Impact of ATP failures

The efficiency of the ATP system which has just been assessed is based on the assumption of a fully available system.

It was then essential to ensure that the loss of efficiency ascribable to failures would not impact adversely on the assessment outcome.

Before the reliability of the ATP system was investigated, an Analysis of Failure Modes, their Effects and Criticality was conducted. Calculations were essentially based on data taken from a study carried out by the system's manufacturer. Mean repair times for calculating availability were taken from statistics relating to the repair times for similar types of safety equipment.

For a stopping sequence, the unavailability rate for the ground-based part of the ATP system is $1.7 \cdot 10^{-4}$. It is largely due to encoders and to some connectors. The unavailability rate for the on-board equipment varies between 13.[illegible]$\cdot 10^{-4}$ and [illegible]0.[illegible]$\cdot 10^{-4}$, depending on the policy in force in respect of the withdrawal of faulty equipment. If assumed to be at 10^{-4}, errors in the coding of train characteristics are negligible. It should however be noted that this value can only be obtained with well-trained and more especially, highly motivated staff.

In all, for a stopping sequence, the unavailability of the ATP system would range between 12.[illegible]$\cdot 10^{-4}$ and $40.4 \cdot 10^{-4}$ depending on the policy in force in respect of the repair of train-borne equipment and the development status of the software.

These figures do not undermine the assessment made of ATP efficiency.

4. Optimizing the investment

We have then examined in turn :

- the scope of the programme to be implemented,

- the timescale to be met with a view to equipping engines and stop-signals in order to maximize efficiency at the investment implementation stage.

4.1. Modelling

Following the assessment of efficiency mentioned in 3.1. a set of values was identified for which graphs were plotted. These graphs reflect the efficiency of the ATP system as a function of the number of engines and stop-signals equipped and indicate that a constant elasticities model should be used.

$Y = kS^{a}.E^{b}$

k = constant

S = number of stop signals equipped

E = number of engines equipped

a and b = coefficients

This model is in line with experimental results.

a : 0.45349

b : 0.45111

k : 0.02645

4.2. Optimum distribution between engines and signals.

The optimum investment-sharing between engines and signals can be derived from the calculations. The split is thus optimum if :

$S/E = C_e/C_s.a/b$
where C_e : cost of equipping one engine
and C_s : cost of equipping one stop signal

Since $a \cong b$, we get $S.C_s = E.C_e$

Investment-sharing is optimized when the investment in engines is equal to the investment in signals, wherefrom you can determine optimum investment scheduling for engine and signal equipment on a yearly basis.

4.3. Equipment strategy

This model and the results of the statistical analysis mentioned in section 3.2 enabled us to assess the efficiency of the KVB system in relation to the number of signals and electric/diesel signals to be equipped.

	Stop Signals	
	Electrified lines	Electr.and diesel operated lines
Electric engines	68 %	68 %
Electr. and main-line diesel engines	81 %	88 %

Taking the assumption in which all stop-signals on electrified lines are equipped, the equipment of diesel engines generates a 13% efficiency gain and the equipment of the additional 2,000 stop signals on non-electrified lines generates another % gain. In fact, diesel engines worked on electrified lines have been involved in 2/3 of instances of signal overruns.

The various simulations conducted lead to the following equipment-programme, whilst keeping to a safety-related rate of return equivalent to other safety-related investment-schemes; it boils down to equipping :

- virtually all stop-signals on electrified lines, i.e. 17,000 signals,

- a fleet of 3,700 electric engines and 900 diesel-operated engines or railcars.

5) Economic aspects (Appendix 7)

SNCF has decided to install ATP in a non-continuous manner. This requires precautions to prevent an adverse impact on drivers' behaviour, especially in non-equipped areas.

Ergonomically, the system is designed to be transparent, i.e. as long as the driver's behaviour complies with the relevant rules and regulations in force, the presence of the ATP system should not be felt or, at least, its effect should be minimized.

This is the reason why the information displayed has been reduced to a minimum. The following data are used in normal circumstances :

- - - : KVB in service on equipped section

00 or 000 : warning for a stop-signal

L : temporary speed restriction (worksite).

Furthermore, other enhancements have to be added to improve system transparency while eliminating all displayed information.

In order to make sure that the driver would not be tempted to lessen his vigilance whilst using ATP intervention to control the train, the following decision was taken : when the driver no longer complies with safety requirements, the system would definitely take over until the train would come to a stop and ATP intervention would be recorded on the speed-recording tape and dealt with as a driving error.

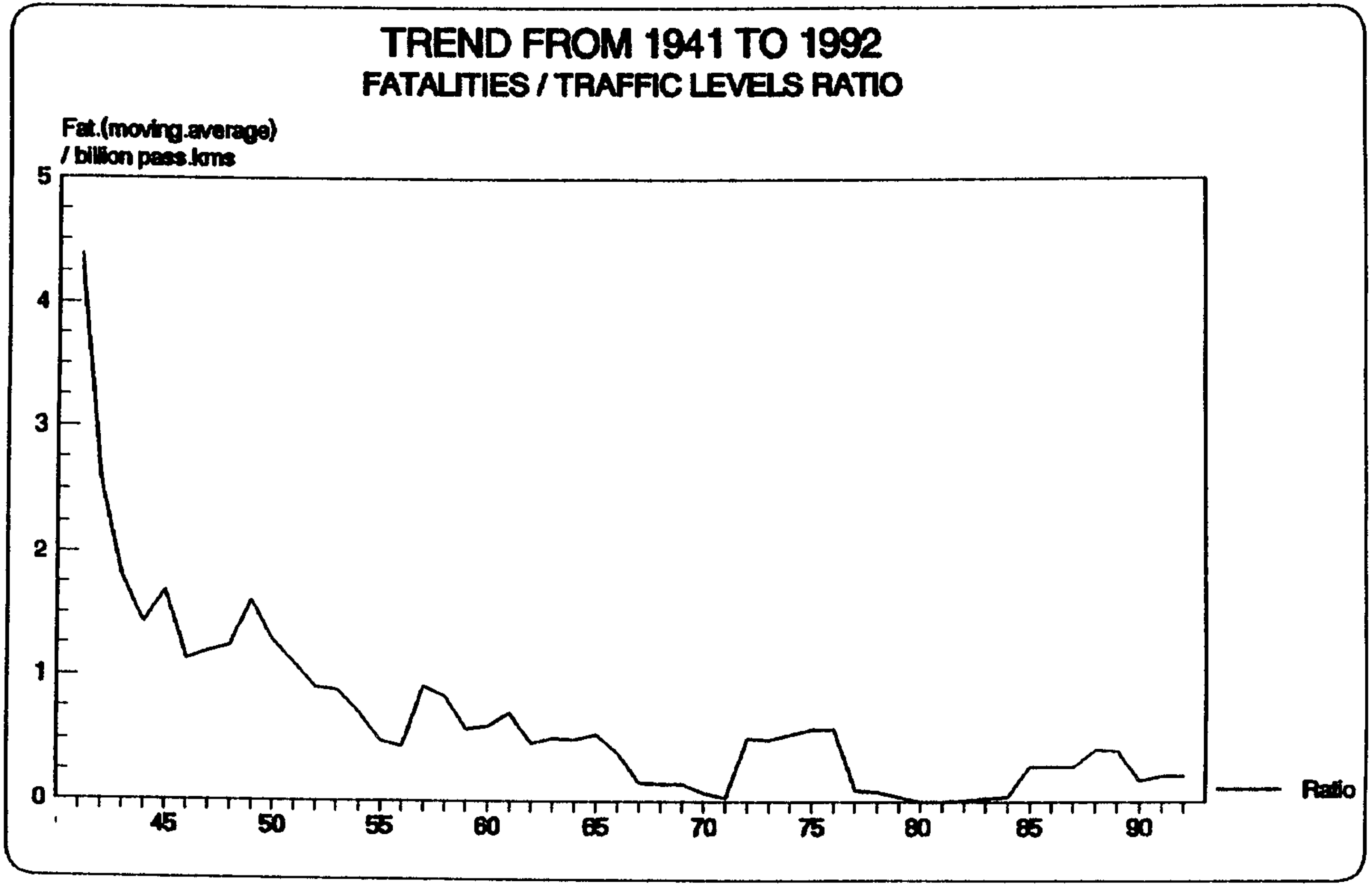
7) Current status of the project

By the end of 1993, 1,[illegible] engines and 3,500 signals will be equipped.

All converging electrified lines should be equipped in 1998 as well as all electric traction units and half of the diesel fleet.

By then, signal overruns and overspeed should no longer be the weak point in the railway safety chain and substantial progress will have been made in terms of accident prevention.

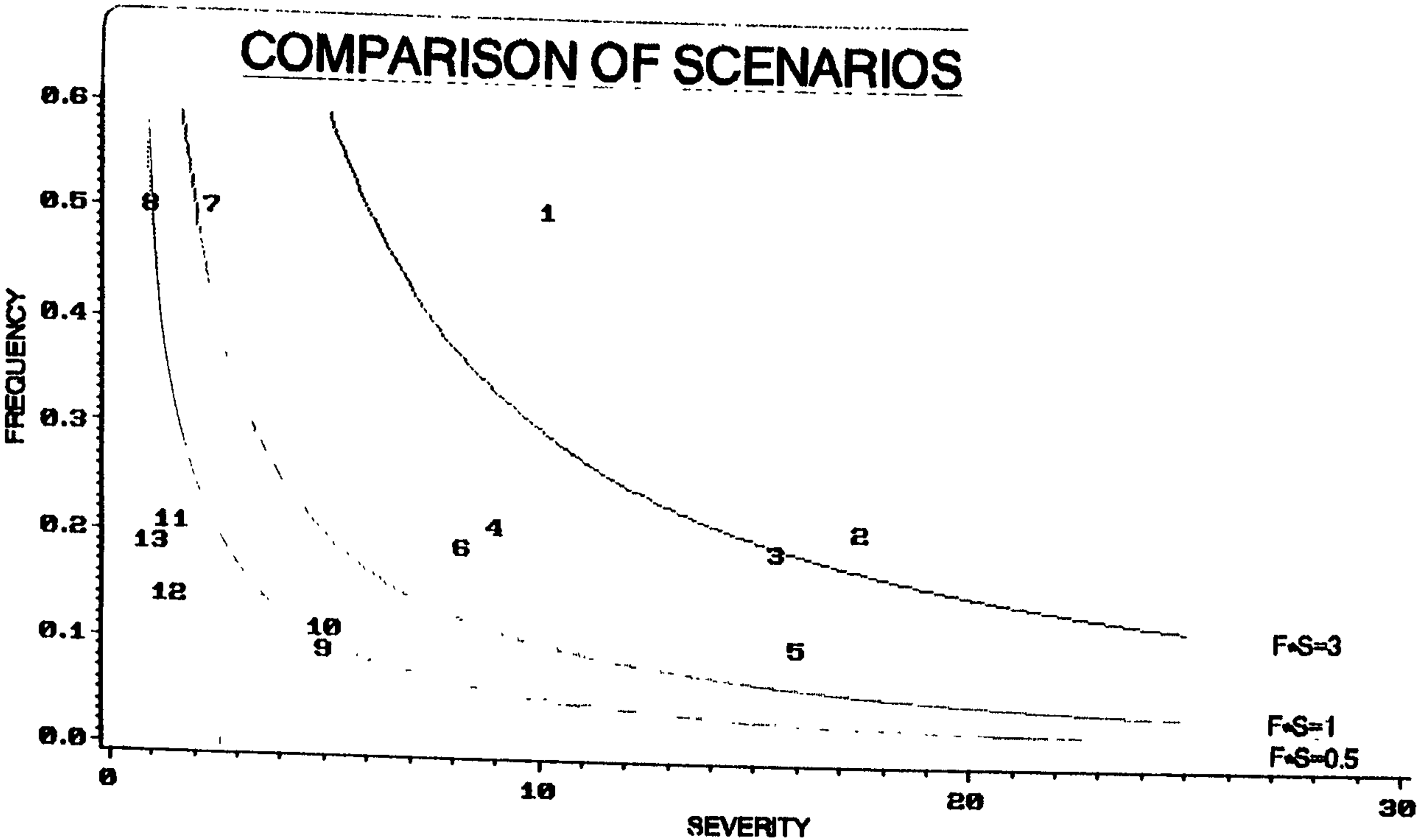
* * *



STATD19

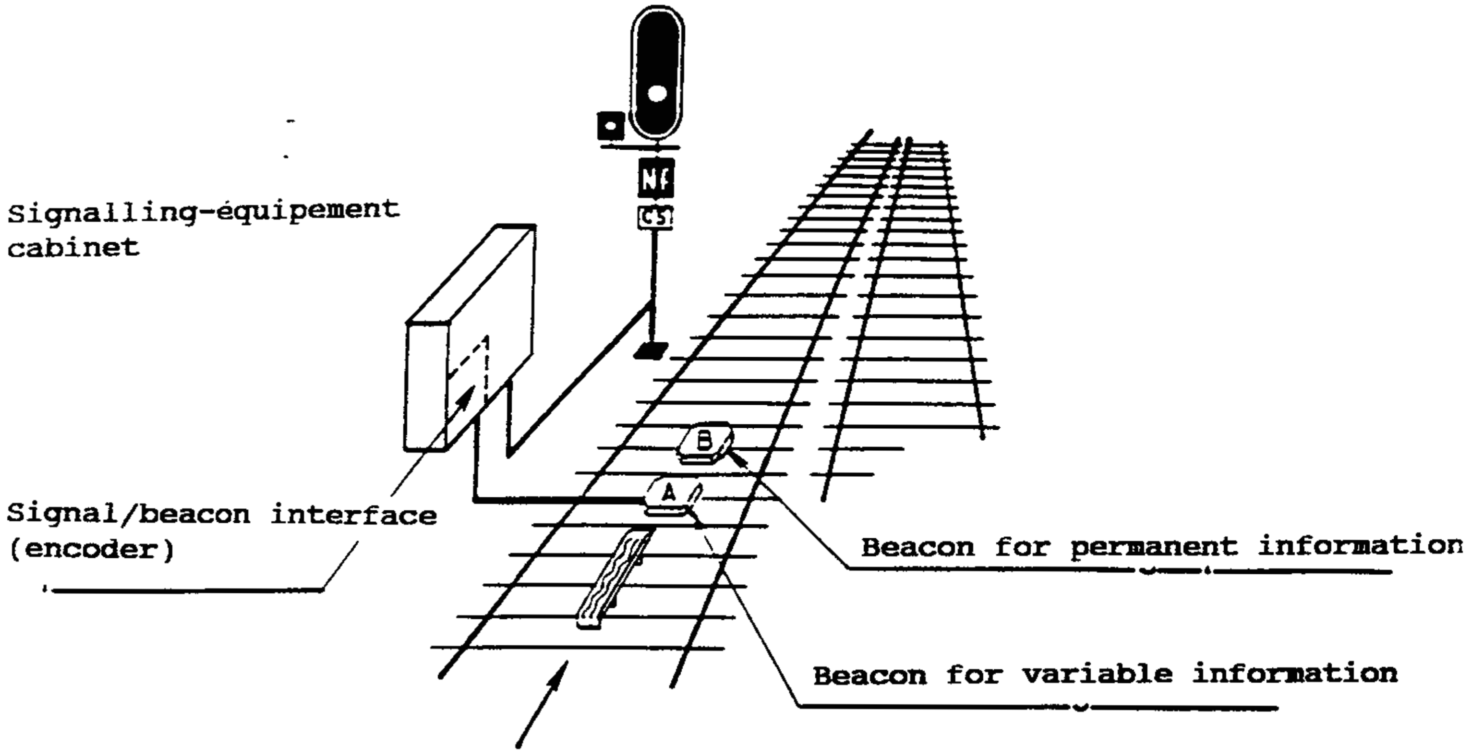
APPENDIX 1

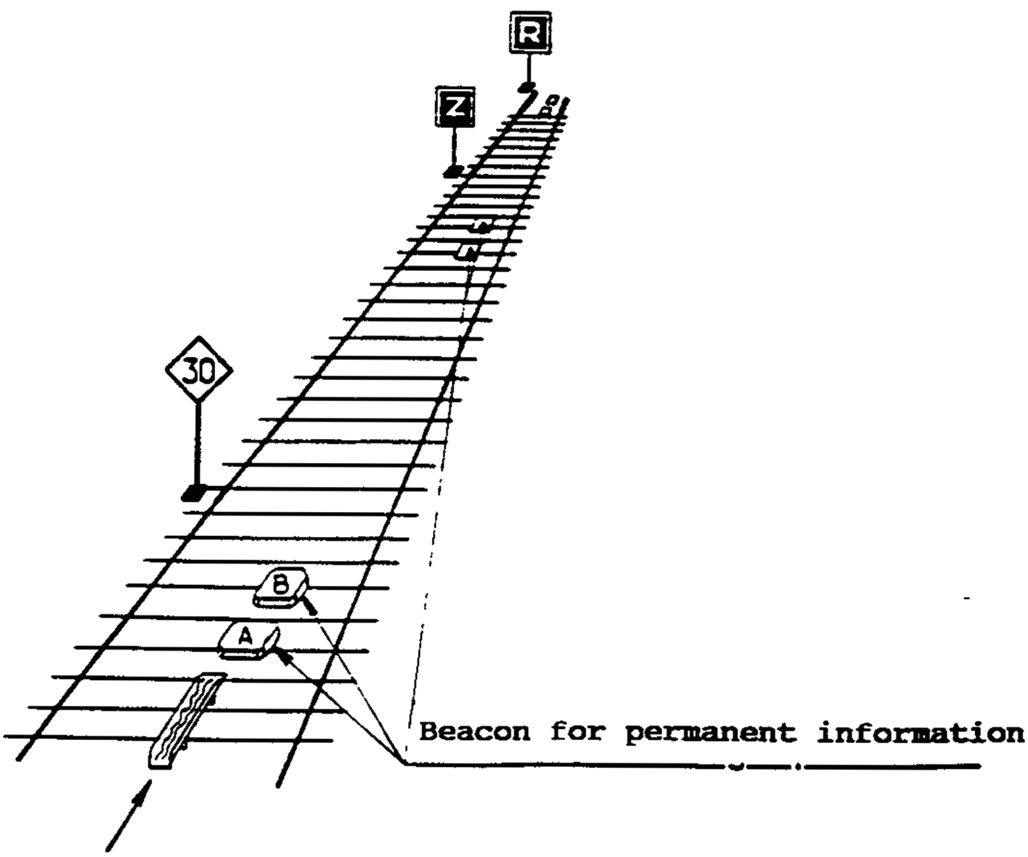
APPENDIX 2

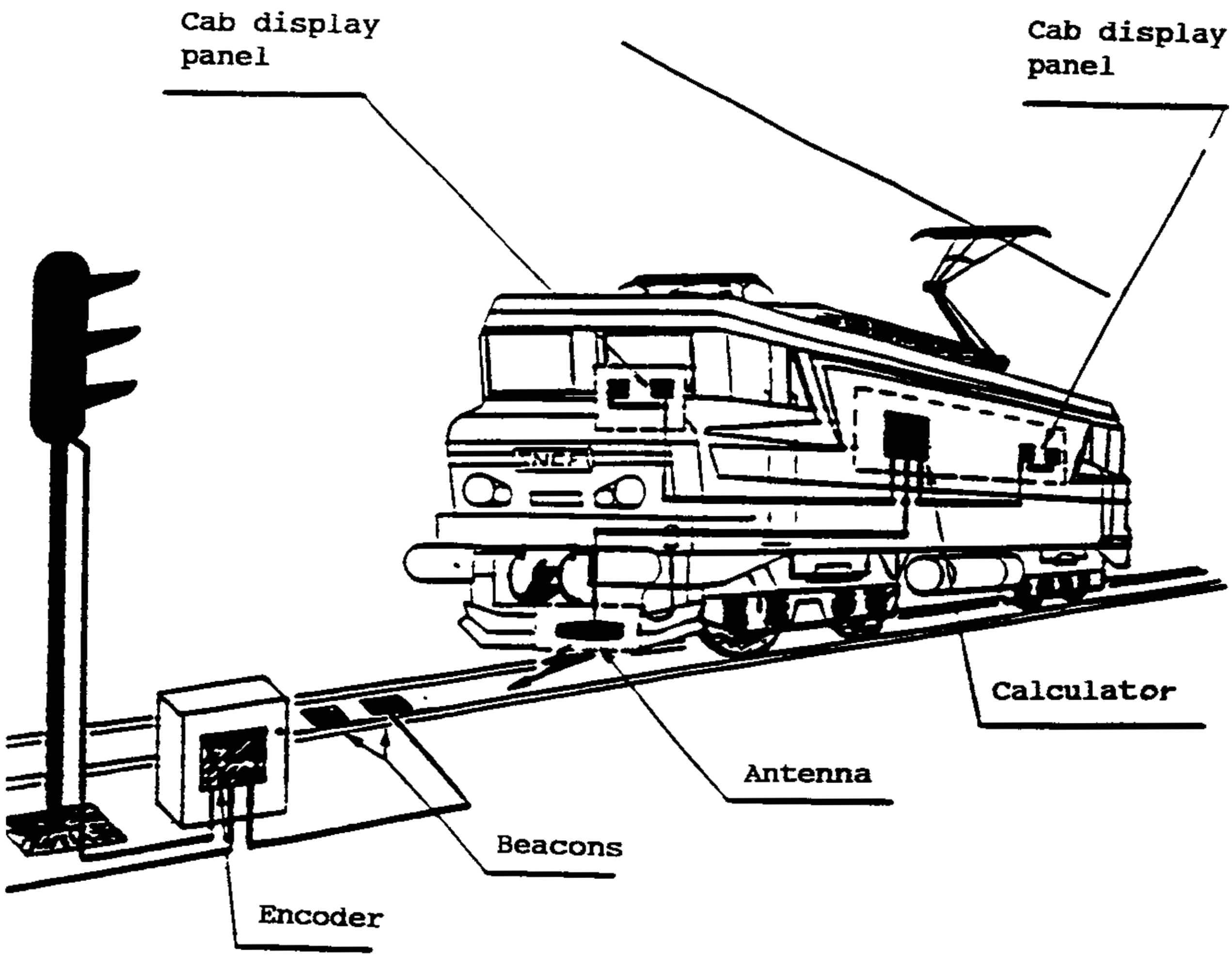

COMPARISON OF SCENARIOS
FREQUENCY
0.0
0.1
0.2
0.3
0.4
0.5
0.6
SEVERITY
0
10
20
30
1
2
3
4
5
6
7
8
9
10
11
12
13
F•S=3
F•S=1
F•S=0.5

LIST OF SCENARIOS

SCENARIOS	No
Accident following stop signal overrun or overspeed	1
Collision with an obstacle on the track (away from level crossings)	2
Collision following brake failure or train runaway	3
Collision following a block error	4
Derailment following track failure	5
Collision with a derailed train	6
Collision at level crossings	7
Accident on sidings	8
Derailment following rolling stock failure	9
Accident following signal failure	10
Collision when running at sight	11
Collision following displaced loading or open door	12
Accident following switching error or reception on occupied track	13

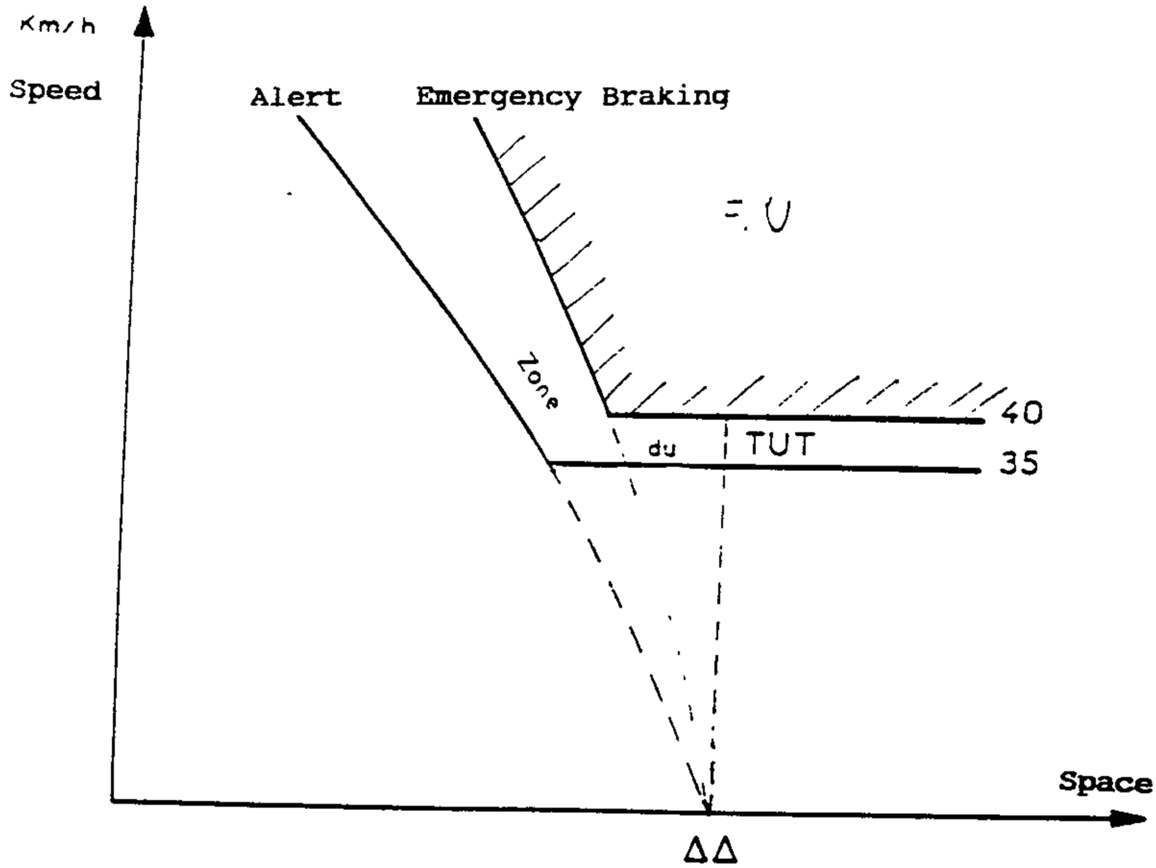

Signalling-équipement cabinet
Signal/beacon interface (encoder)
B
A
Beacon for permanent information
Beacon for variable information


R
Z
30
B
A
Beacon for permanent information

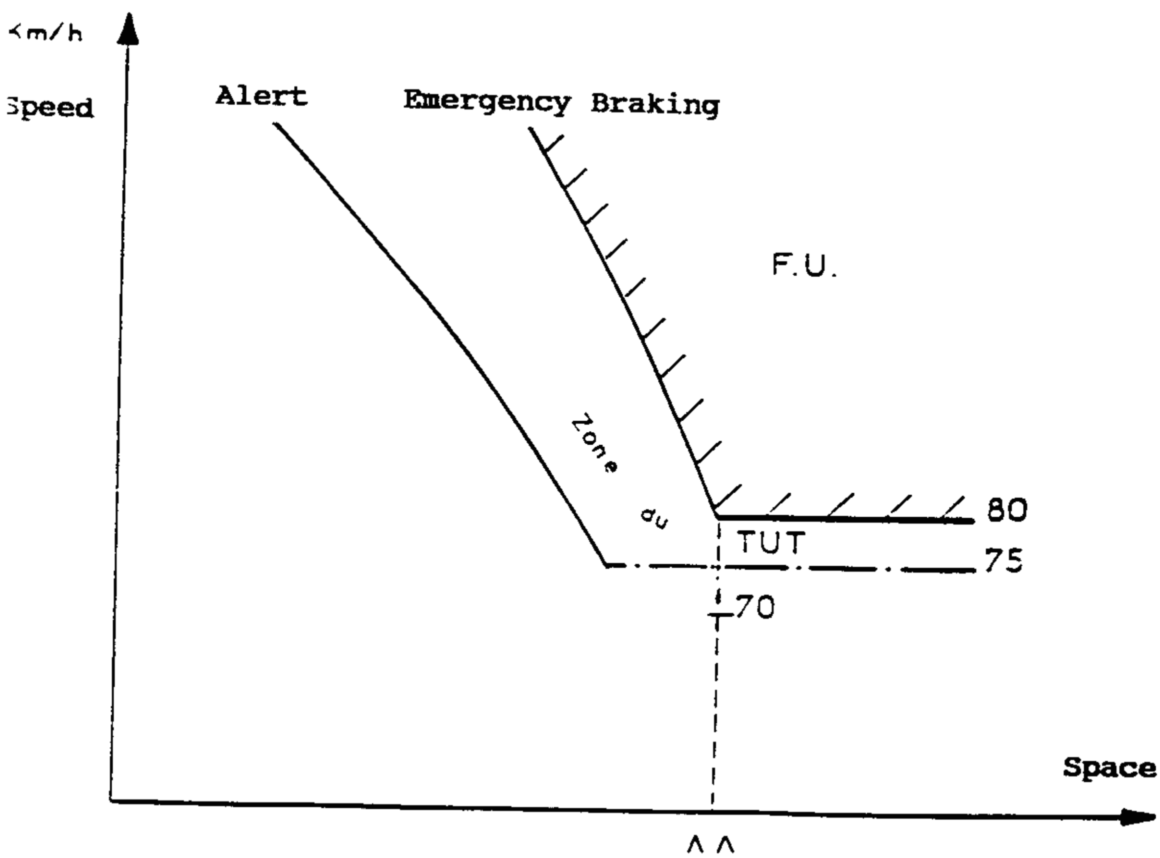

Cab display panel
Cab display panel
Calculator
Antenna
Beacons
Encoder

APPENDIX 5

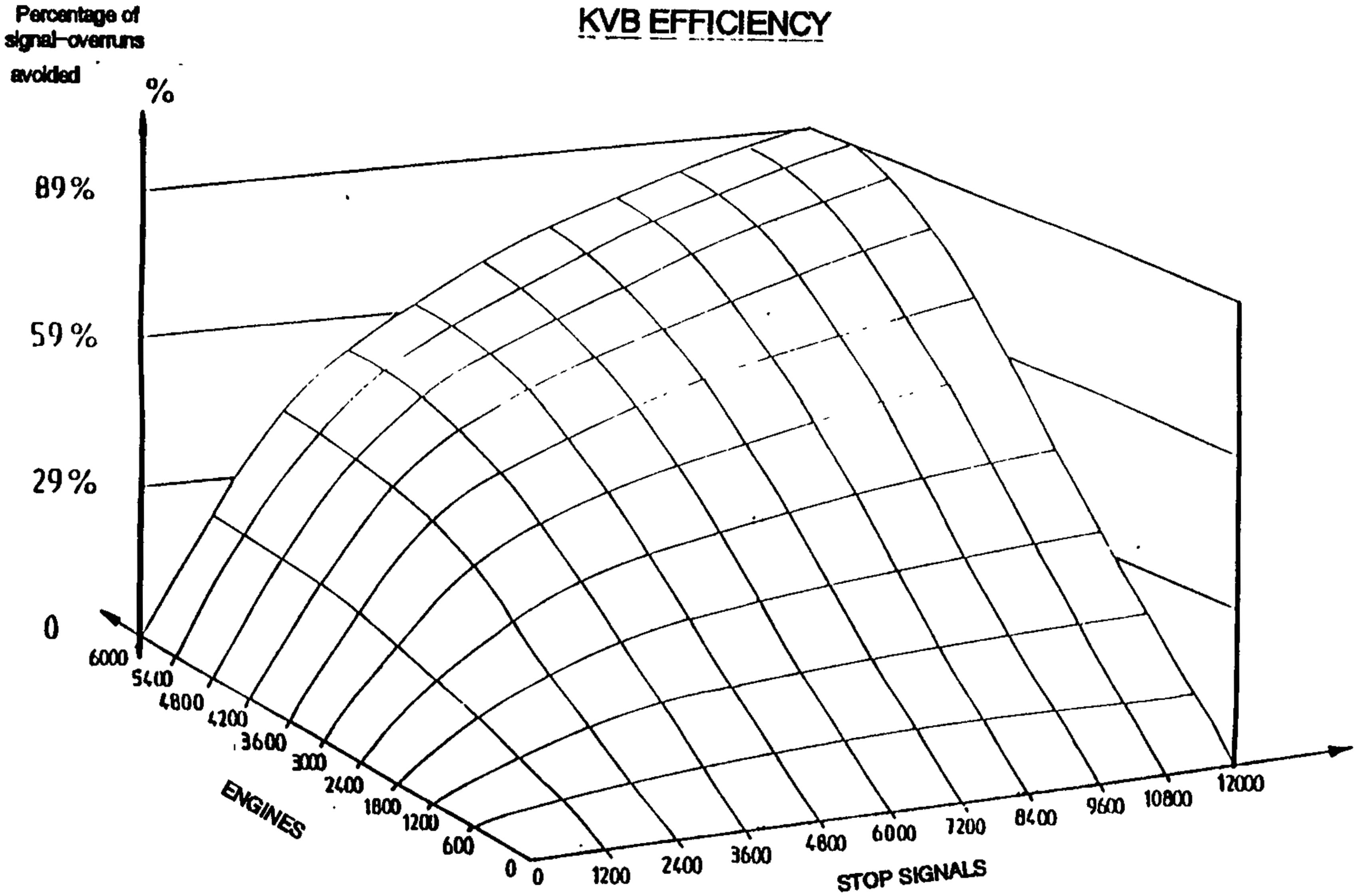
STOP SIGNAL WITH OVERLAP



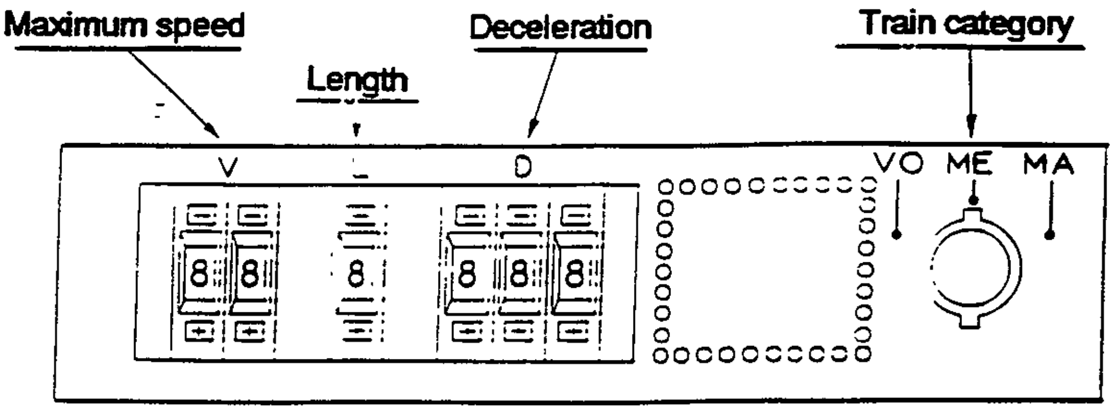
SPEED RESTRICTION 70km/h



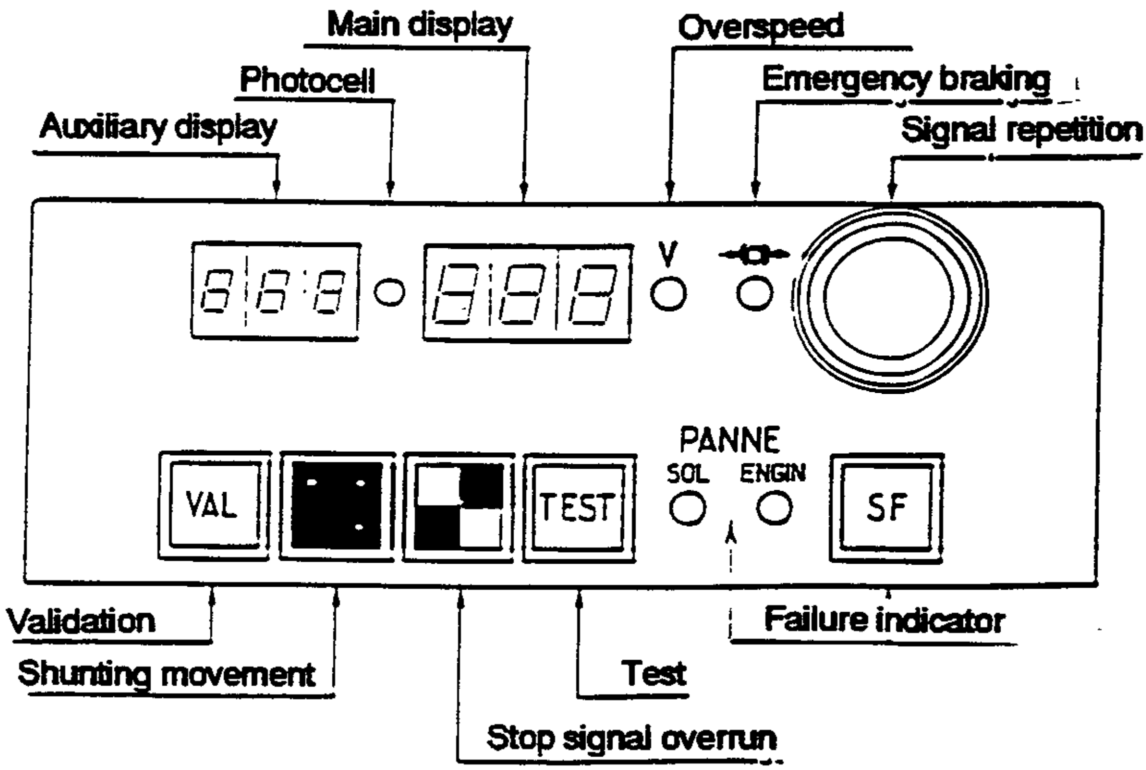
KVB EFFICIENCY



APPENDIX 6



DATA INPUT PANEL



DISPLAY PANEL

International Rail Safety Conference

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9333

Jan Swier

The development of a new level crossing policy in the Netherlands

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

THE DEVELOPMENT OF A NEW LEVEL CROSSINGS POLICY IN THE NETHERLANDS

Jan SWIER

Terminal Staff
NV Nederlandse Spoorwegen

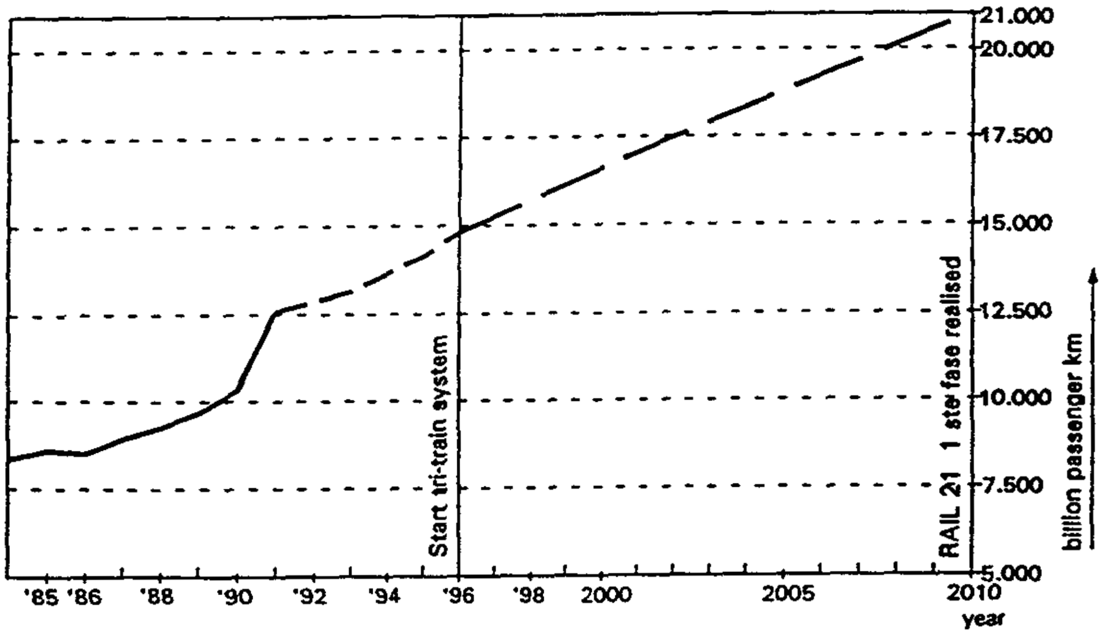


Fig. 1 *Transport volume forecast 1992-2010 as a result of Rail 21*

Grounds for a new level crossings policy

Mid-1988, Netherlands Railways (hereinafter called "NS") issued "Rail 21, a proposition to society". This aims to elaborate on the expanding role of public transport in the nation's overall mobility, as required by the government. The principal target contained in the plan is to double the volume of transport to 21 billion passenger kilometres per annum by causing use of cars to change to use of trains (fig.1). In doing so, NS will be able to contribute significantly to solving the increasingly urgent social issue of both threatened accessibility and quality of life.

To achieve the above target, the infrastructure will be expanded and adapted and, as part of Rail 21, NS will introduce a three-train system so as to substantially increase its transport capacity and attain important qualitative improvements. The three-train system will enable NS to offer a product that responds more closely to customer requirements, allowing the train to compete more sharply against the car and thus to replace car mobility by train/public transport mobility.

The characteristics of the new three-train system are more capacity and better, faster and more comfortable transport. The expansion of the transport capacity will largely be realized through new double-decker stock. Therefore, the target of double the number of passenger kilometres by the year 2010 will "only" require 1.5 x the number of trains. Which will travel faster on long distances in order to realize the required improvement in the quality of service: shorter travel times, improved punctuality, higher capacity and increased frequency.

Realizing the improved product will demand a large number of infrastructure projects to be carried out. These are to be financed publicly and will cost some Dfl. 17 billion. In addition, dramatic expansion in terms of rolling stock, railway stations, siding equipment and the like will be necessary, to be financed entirely by NS.
No rise in real terms in the government's contribution to operating costs will be necessary, provided that, the government timely establish an effective flanking policy to both steer and influence car mobility.

It will only be possible to effect the rail services model envisaged on the basis of Rail 21 if the infrastructure is radically expanded and improved. For more than 20 years now, The Netherlands have been operating a highly intensive and complex rail service on a network counting hardly any line sections of more than 2 tracks. Trains which approach certain junctions virtually simultaneously due to common connections should not hinder one another. It will therefore be necessary to construct fly-over junctions in locations where trains, as yet, cross level.
Apart from speeding up services by preventing time being wasted at junctions, a second possibility to improve rail services lies in increasing the speed of travel. To date, the maximum speed permissible by law has been 140 km/hour. The Rail 21 plans envisage an increase to 160 km/hour for part of the routes, and for Eurocity and Intercity routes, a speed of 200 km/hour or more is considered.

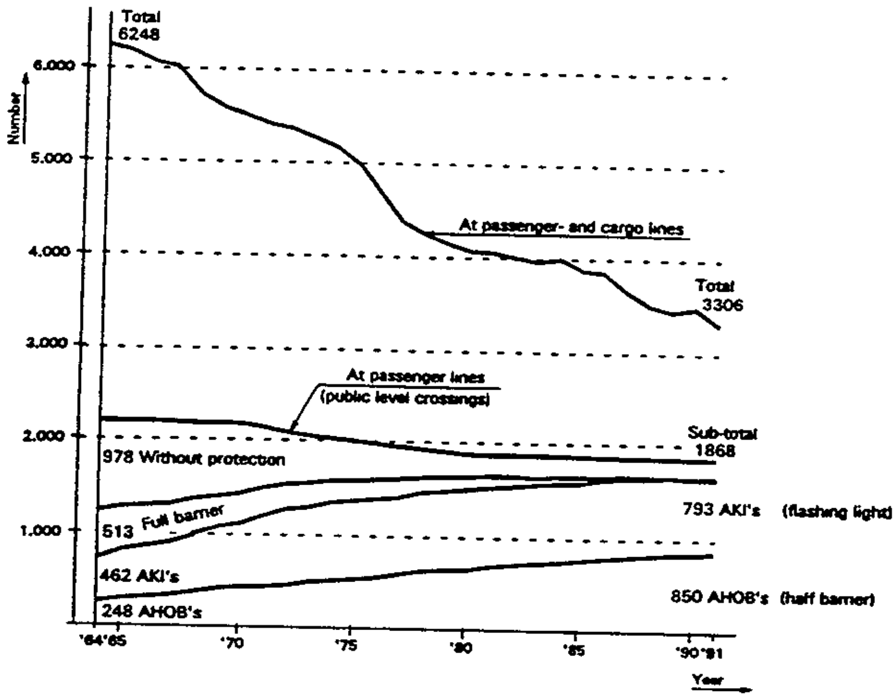


Fig. 2 *Evolution of the number of level crossings during the period 1964-1991*

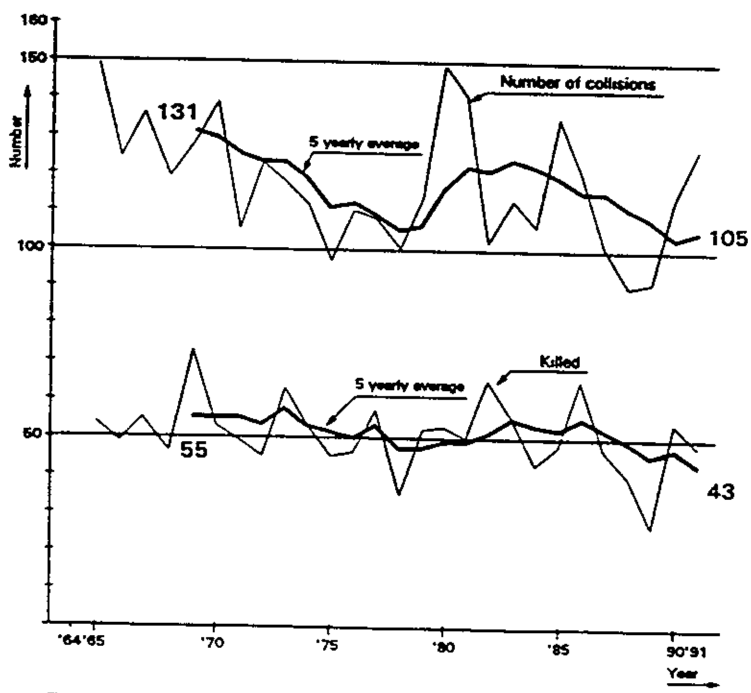


Fig. 3 *Evolution of the number of collisions during the period 1964-1991*

The alterations to the speed limit resulting from Rail 21 directly occasioned a new level crossings policy to be formulated. It would become evident at a later stage that speed is neither the only, nor even the main cause of the higher risk at level crossings.

Existing level crossings policy

For many years, this policy has aimed at reducing the number of level crossings. A few simple rules support this:

- a new level crossing is only approved if an existing one is discontinued (compensation regulation)
- newly constructed lines may not contain level crossings
- where there are more than 3 tracks, public protected level crossings may no longer be utilized.

Since 1964, the number of level crossings on passenger routes has fallen as a result of this policy from more than 4200 to nearly 2800, a decrease of 35% over a network length that has remained more or less the same (fig.2).
During the same period, the number of level crossings protected with whole or half barriers and flashing lights has risen from 1240 to 1760, an increase of more than 40%! Where routes have been modernized, the guarded barriers have, on a large scale, been replaced with automatic protection installations (automatic half-barriers or automatic flashlight installations), with the result that there are now less than 10 guarded barriers on passenger routes as opposed to more than 500 in 1964.
It should be noted, though, that over the last few years, it has become increasingly difficult to reduce the number of level crossings. As NS hardly has a budget at all, financing measures to improve safety is dependent on changes provoked by road operators, forcing the latter to pay for them.
Each year, some 100 collisions occur at Dutch level crossings with an average of 42 casualties p.a. In the last few years, the incidence has fluctuated but overall has fallen slightly, in spite of much increased car mobility and frequency of train services. The acceptance limit for traffic accidents, however, is also on a downward trend (fig.3).

Risk studies and fact finding abroad

Raising the speed limit in particular caused NS to consider the question whether level crossings are still acceptable, and if so, on which conditions. Dutch railway law presently states that the maximum speed of passenger stock must not exceed 140 km/hour and that only the Minister may permit a higher speed, on conditions set down by him/her.

For this reason, NS commissioned CROW Consultancy in 1990 to research the effect of a higher train speed on the chances of collision at level crossings. The CROW investigation focussed particularly on a qualitative analysis of the consequences of higher train speeds.

The government carried out a second investigation itself, to be able to supply quantitative grounds on which to base a ministerial decision on whether or not to raise the speed limit. SAVE Consultancy were ordered to produce a risk analysis, drawing

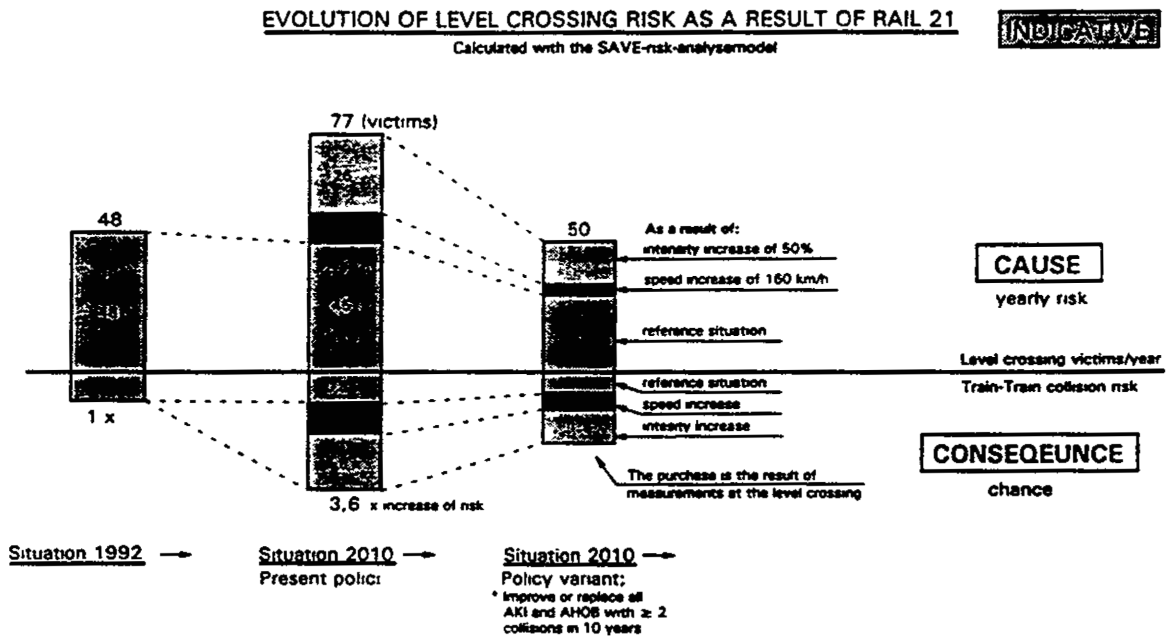


Fig. 4 *Evolution of level crossing risk as a result of Rail 21*

on the incidents that occurred between 1981 and 1989, of the likely consequences of a higher speed limit. Case histories relating to the nature, number and circumstances of collisions over the last years, as well as to the number and type of level crossings involved in the incidents, were made available by NS for the purpose of this study.

Both studies were based on the principle that above 160 km/hour, public level crossings would not be used at all.
The studies supplement one another. Risk changes identified in the CROW Report are quantified in the SAVE Study by means of a risk model developed (fig.4).
A summary of the main conclusions of both studies is given below:

- Accidents on protected level crossings occur when the protection is ignored, either deliberately or subconsciously.
- It cannot be demonstrated that travel at 160 km/hour, in itself, will significantly affect the future incidence of collisions.
- Slower trains on 160 km/hour routes might give rise to a higher risk of a collision with a road vehicle. This is due to the greater length of time in between the safety devices announcing the imminent approach of a train and its actual arrival, causing the level crossing safety devices to be ignored more frequently. The rise in the number of victims as a result of the speed being raised to 160 km/hour will therefore be approx. +15%.
- Train passengers run hardly any risk of being injured in accidents at level crossings. The risk of casualties in a level crossing collision increases at a higher speed because the chance of the train derailing and the consequential chance of a train/train collision is greater, as a derailed train might end up in the Clearance Area <u>and</u> an approaching train might not be able to stop in time.
- The mean chance of this happening to NS stock at 140 km/hour is 2%. Modern, lighter trains seem to be more susceptible to derailing. The chance that modern IC 3 stock derails at 140 km/hour is 10% and is expected to be double that figure at 160 km/hour.
- The intensity of the train services will be the main factor to affect the number of collisions to be expected between rail and road traffic and therefore also any sequential train/train collisions. The effect will be directly proportional to the increase in the intensity of the train services, i.e. +50%.

Principle of the new level crossings policy
In general, the policy may be defined as "laying down the method by which an organization wishes to attain an objective". The new level crossings policy will have two main ones. The first is to prevent the number of collisions at level crossings, and therefore the number of victims, from increasing and if at all possible to cause these numbers to decrease. The second main objective is to minimize the risk of consequential damage arising from trains derailing and sequential train/train collisions taking place. Derived targets of the level crossings policy are therefore to improve both road safety on level crossings and rail safety in case of a level crossing collision.
The objective of a policy should be as clear as possible and is influenced by (available) methods and prior conditions. The latter can vary widely. The extent to which methods

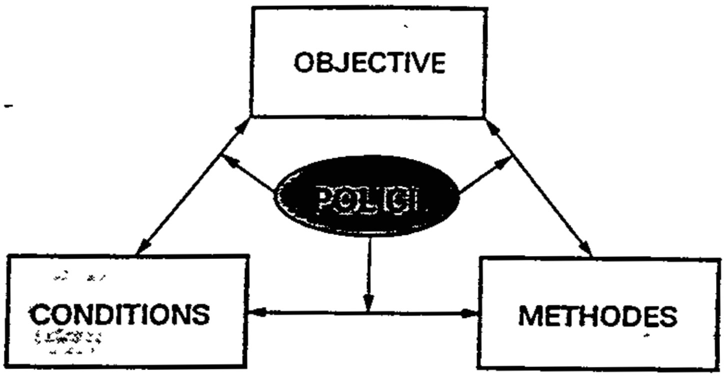
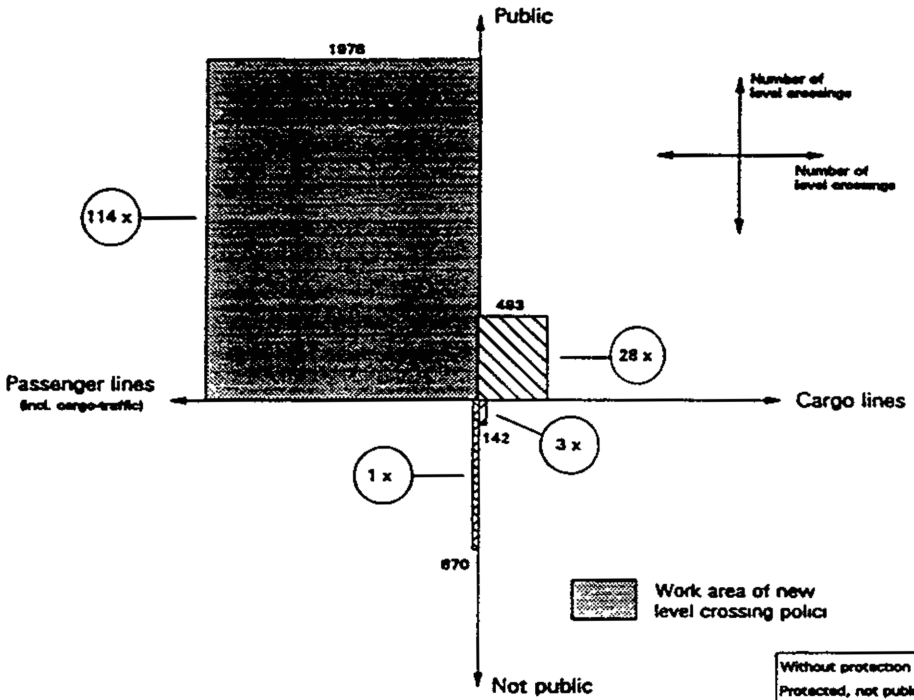


Fig. 5 *Factors which affect the policy*



	1990				
	Passenger lines		Cargo lines		Total
	[illegible]	Not Public	Public	Not Public	
Without protection	228	859	254	137	1478
Protected, not public	–	6	–	–	6
AHOB (half barrier)	[illegible]	4	41	–	873
AKI (flash light)	[illegible]	1	32	5	842
Remaining types	118	–	166	–	284
Number of level crossings	[illegible]	870	493	142	3483
Number of accidents	[illegible]	1	28	3	146
Number killed	[illegible]	0	2	1	57

Fig. 6 *Sphere of activity for the proposed new level crossings policy*

impose limits on the target to be obtained depends on the ingenuity of the manager and the technological possibilities.

NS's new level crossings policy was formulated after as complete a listing and analysis of targets, prior conditions and methods as possible (fig.5). The listing has been summarized in a report called "The ingredients for a new level crossings policy", which was submitted to the Minister of Transport along with a NS mission and recommendations document. For the time being, the proposed new policy deals solely with passenger routes and public level crossings as 80% of all accidents take place there, resulting in 95% of the total number of victims on level crossings (fig.6).

PRIOR CONDITIONS for the new level crossings policy
To prevent the hazards at level crossings from increasing, it is necessary to improve existing level crossings, to convert them to a different protective system or to replace them with fly-overs.

It has become clear that the budget for Rail 21 does not suffice to cover all intended projects. Nevertheless, NS is loath to amend Rail 21's objective. The target, doubling the number of passenger kilometres to 21 billion by the year 2010, remains the same. This can only be achieved through optimizing and rationalizing, i.e. maintain functionality with less means (that is, costing less). In other words, maximum functionality against minimum life cycle costs. The level crossings policy, too, will have to be subject to this philosophy and should provide solutions such that the Rail 21 plans may be carried out along the lines of the amended plans.

(RISK) TARGETS new level crossings policy
Is an increase in the number of victims at level crossings acceptable or not? This question belongs in a more general context, namely which level of risk is socially acceptable? A consistent guideline does not seem to exist. Whether or not a high risk activity is tolerated depends on both objective (e.g. business-economic) and subjective (e.g. political) factors.
Only qualitative statements seem generally applicable: "The individual and social risks inflicted by high risk industries must be kept to a minimum. The desirability of the product and the technical feasibility of reducing the risk must be weighed against the cost of such restrictive measures and the possible effect of an undesirable incident".
There is no clear-cut limit above which risks are not accepted and below which they are. In a quantitative sense, this may be phrased as follows:
"There is a level of risk at which no-one may be excepted. There is also a level of risk which will not present a problem to anyone. In between the two, the ALARA (As Low As Reasonably Achievable) principle applies".

To be able to define the target for the new level crossings policy, target-determining factors were therefore listed and analysed. The following factors were recognized:

	Amount of level crossings (1990)	Victims/year on 1000 levelcrossings (1990)
Netherlands	3.483	16,4
Belgium	3.141	4,4
W-Germany	20.267	2,7
Denmark	1.933	2,6
France	21.286	2,7
England	?	0,4

	Trainfrequency It	Roadtraffic intensity on levelcrossing s Iw	It xIw	Relative comparison factor
Netherlands	120	3600	430.000	5,4
Belgium	80	1600	130.000	1,6
W-Germany	60	3100	190.000	2
Denmark	60	2000	120.000	1,5
France	40	1900	80.000	1
England	70	3600	250.000	3,5

Fig. 7 *International risk comparison*

1. Social standards
2. Road safety policy standards
3. Foreign railway companies' standards
4. Business-economic factors
5. Personnel health and safety
6. Company image; passenger safety
7. Company image; punctuality

The government will place the highest priority on the first few factors. For NS, the last few are the most important. This does not imply any kind of conflict, however. Rather, it illustrates a difference in primary responsibilities, causing different aspects to be emphasized. This realization should not be underrated as it allows apparently opposed views to be explained and, thus, discussed.

In principle, a negative change to an existing, accepted level of risk, is not generally acceptable, unless the risk is already minute (Stand still principle).
If mobility, together with all ensuing risks, is considered in an integral sense, it stands to reason that, as a result of the growth of public transport and the subsequent reduced growth of road traffic, the risks will shift. In fact, they will shift in a favourable manner as the rail/level crossing risk is considerably smaller than the road traffic risk.

To arrive at a definition of a risk standard, one could also take into account road traffic standards and policy targets. In The Netherlands, road traffic accounts for 1400 casualties and 54,000 injured persons each year. The objective there is to reduce the number of victims by 25% before the year 2000. Road and rail do not really bear comparison in this respect, however. The transport systems are essentially different, possess wholly specific safety characteristics and make use of entirely different methods to affect that safety. This is confirmed by the large disparity in the ratio of the number of collisions to the number of casualties. At level crossings, this ratio lies in the region of 2:1 - for road traffic, the ratio is 40:1.
Notwithstanding the above, the fact that a risk reduction for road traffic is pursued can provide guidance in determining the safety risk target for level crossings.

A risk standard for level crossings could also be derived from the norms applied in the railway companies in our neighbour countries. On the surface, this would be simple enough but in practice, it is a recipe for problems. After all, quite a few factors influence the results: the intensity of train services, the number of level crossings, the density of the road and railway network, mobility, mentality, etc.
Taking stock of the Belgian, Danish and German level crossings policies has shown these countries to enforce far more active level crossings safety policies than The Netherlands. Their governments annually make available substantial sums of money to replace level crossings with fly-overs or to improve the safety system. The result is a number of accidents that is absolutely and/or relatively lower (by far) than in The Netherlands (fig.7). On the other hand, the intensity of both road and railway traffic in The Netherlands is 3 to 4 times higher than in other European states.

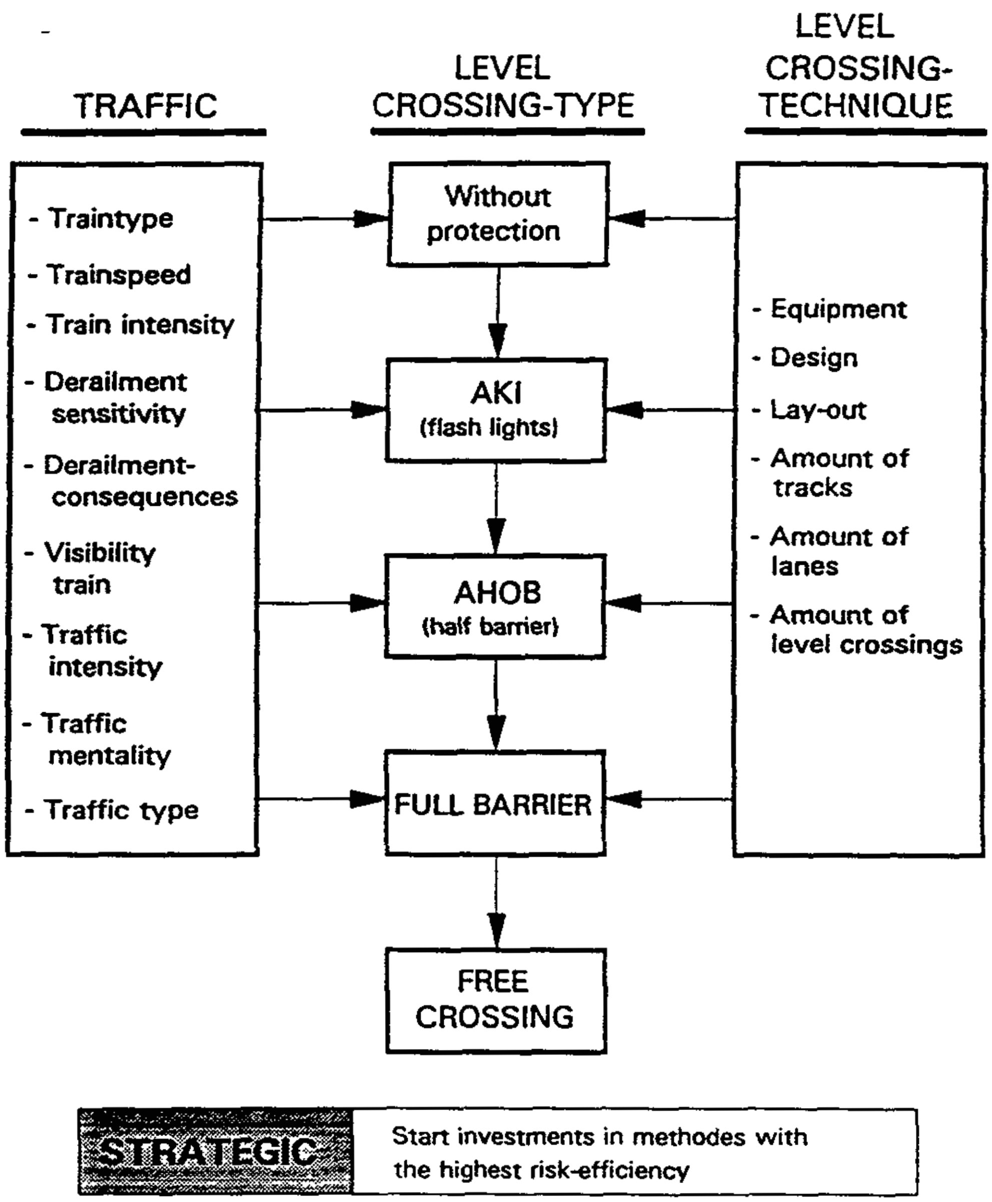


Fig.9 Affecting the safety on level crossings

To a company like NS, the factor of image is crucial. Its role as a public transport company makes issues such as safety and punctuality important image-setters. Without compensatory measures, the intensified level of services and higher train speeds of Rail 21 will increase the risk of collisions at level crossings and the factor of image must therefore also play a part in determining the target.

Last but not least, considering one's personnel may affect the target. When a train comes into contact with a road user, the latter may be seriously injured or killed as a consequence of his/her own high risk driving. At near-collisions, however, road users are spared the consequence of their actions, yet each collision and near-collision is consciously lived through by the train driver and is a traumatic experience for the staff concerned. An experience which can affect both employees' physical and mental health and therefore provides sufficient grounds for the employer, NS, to incorporate this consideration as a target-determining factor too.

METHODS which may affect the risk for level crossings traffic (fig.8)
The factors that bring an influence to bear on the risk for level crossings traffic may be divided into four categories. Methods may then be derived from the four categories to manipulate the risk;

1. The first category is the choice of the type of level crossing, depending on the volume of traffic, the width of road and the local conditions.

   One option to come under this category is to influence the risk by abolishing all level crossings on routes on which trains have to travel faster than 140 km/hour. In The Netherlands, this would result in the replacement of more than 850 level crossings, estimated to cost approx. Dfl. 9 billion. To choose solidly for this option would mean far-reaching, adverse financial and planological consequences, including the disadvantage of having to replace certain level crossings at which no accidents are ever expected to occur in the future. The cost/benefit ratio is therefore highly unsatisfactory.
   Accident analyses show clearly that improvements to existing types of level crossings are still possible, but also that there are large fluctuations in the cost effectiveness of the various risk-reducing measures.
   The most rigorous and conclusive measure is to abolish all level crossings. Although NS will obviously continue to work towards a reduction, wherever possible, in the number of level crossings and therefore in the likelihood of accidents, one should bear in mind that such a policy would entail major, very expensive planological consequences. It should also be pointed out that, at the majority of level crossings by far, hardly any incident ever takes place and there are relatively few level crossings where collisions occur more or less regularly. The challenge is to find and eliminate the level crossings that are less safe. An analysis with a Poisson distrubutions shows that it is likely that their is such a group (fig.9). In The Netherlands, level crossings at which 4 collisions have taken place over a period of 10 years are considered to be crossings susceptible to incidents which must be improved or replaced. With the new policy we are inclined to tighten up this criterion to about 2 collisions in 10 years (fig10).

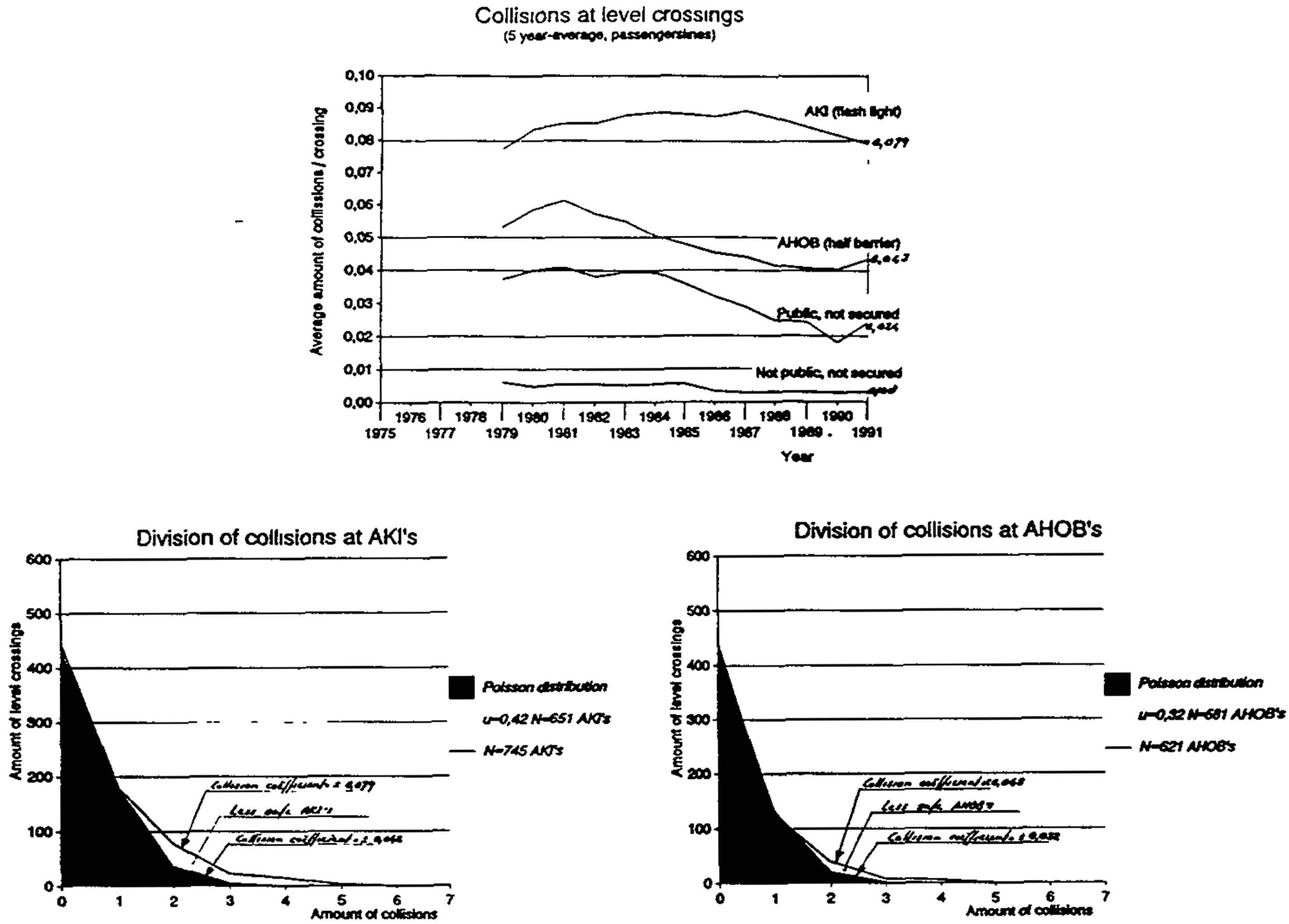


Fig.9 Division of collisions and collision-coëfficients at level crossings

	Present policy (1991)	(possible) new policy
Full barriers	-	<0,015
Half barriers (AHOB)	0,043	0,032
Flash lights (AKI)	0,079	0,042
Public, not secured	0,024	0,02
Privat, not secured	0,003	0,0025

Fig. 10 Collision coefficients of level crossings

2. A second line of approach is traffic-related and/or ergonomic: to improve existing, standard types of level crossing or to introduce a new type.

   Preventive measures are most effective when the choice of protection deployed is based on either a forecast of or the actual load of traffic. A measure can also consist of the development/application of a new type of protection such as complete closure by means of automatic half-barriers. NS has already had ergonomics research carried out for the purpose of arriving at a method to protect level crossings as effectively as possible. One of the features in terms of improving safety of such a method is that the road/railway tracks are completely closed off. This concept will therefore be developed further, taking experience abroad (e.g. in Sweden) into consideration, to try and find a cost-effective solution to a new level crossings policy.

3. The third group of methods is much more convoluted and concerns changes to the traffic making use of the level crossing - deploying types of train which, for each type, display characteristic behaviour in a collision, altering the speeds at which the trains travel as well as the frequency of the services, measures that will affect the observation of the train. Furthermore, this category concerns methods which try and alter the volume of traffic (number and/or category of users) or control the driving behaviour on the level crossings (educational measures).

   One of the methods in this category is to educate road users, particularly in how to behave on level crossings. It has therefore been proposed to intensify such activities. By specifically targeting high risk groups, NS will attempt to banish high risk behaviour. To make a start, two catchy films were released in the last few years, "Red eyes" for youths between 14 and 18 years of age, and "Marianne" for 10 to 14 year olds.
   Research into foreign railway companies has shown that in countries neighbouring The Netherlands, automatically protected level crossings are generally accepted at speeds of up to 160 km/hour without leading to any demonstrable risk increase. Only at speeds exceeding 160 km/hour are fly-over solutions substituted for level crossings. NS intends to adopt this point of departure for the new level crossings policy.
   Fitting track clearers to limit the risk of derailing is another measure that deserves mention here. NS has decided to fit these on all new rolling stock and is considering also equipping its existing IC 3 stock, which is to travel at 160 km/hour, with track clearers.

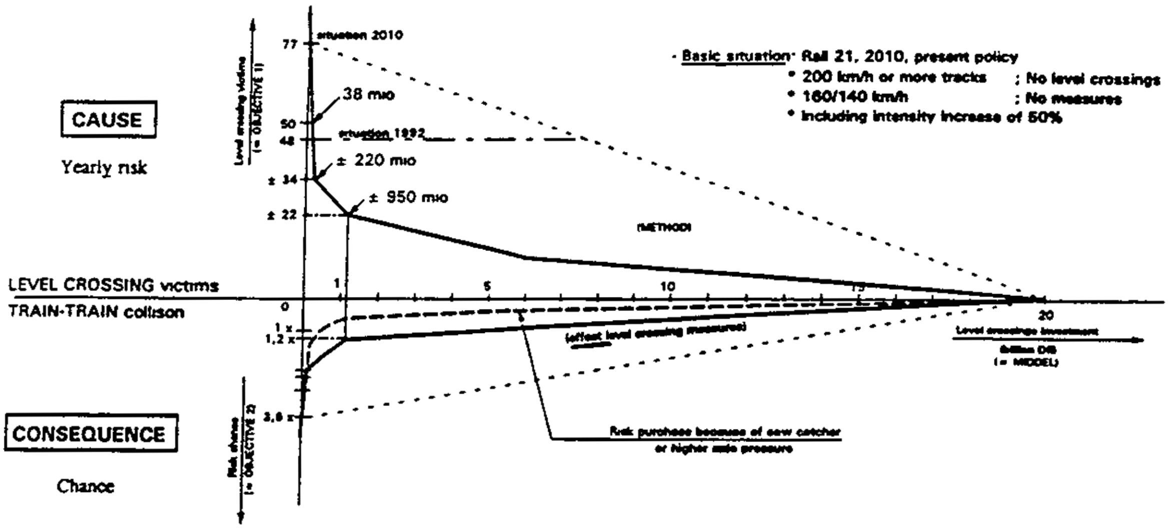
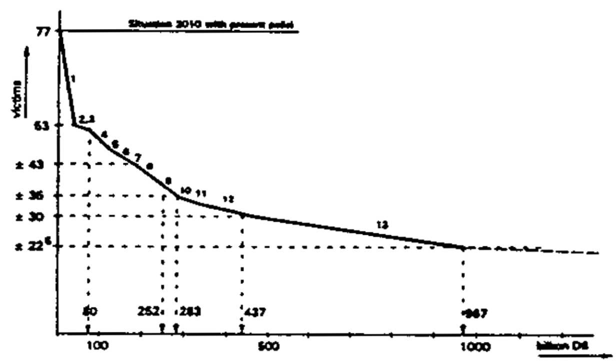


Fig. 11 *Diagram of risk/costs level crossings policy*



Methods	Costs	Victim reduction	Average costs/ victim
1 AKI-rebuild to AHOB	38 bil.	- 27 vic.	2 bil/vic.
2 Protection privat level crossings (160-system)	29	- 1	29
3 Protection non-protected public level crossings	13	- 0,5	26
4 AKI-rebuild to AHOB (140-system)	45	- 4,5	10
5 Second train accident	20	- 2	10
6 Education	10	- 1	10
7 Modification or canceling AKI (140-system)	16	- 1 5	11
8 Slalom prevention	45	- 3	15
9 Raise attention-valve AKI and AHOB	30	- 2	15
10 Reconstruct or cancel AKI (140-system)	19	- 1	19
11 Reconstruct or cancel private level crossings	12	- 0 5	24
12 Reconstruct or cancel AHOB (160-system)	154	- 4	39
13 Reconstruct or cancel AHOB > 2 collisions	530	- 10	53
	967 bil.	- 59 vic.	

Fig. 12 *Diagram of methodes for level crossing measures*

4. The fourth and final method of affecting the level crossings traffic hazards lies in the strategy applied in striving for improved traffic safety at level crossings.

   If a risk increases, it is advisable to target a previously established objective, based on the minimum requirements of a safety level to be met by the total of all level crossings. By taking measures which are specific to the existing situation, an acceptable safety level for level crossings may be achieved at a considerably lower cost. It is also true that, in practice, the planning required for the realization of extra provisions can more easily be integrated with the changes in speed and the frequency of train services than the far more drastic (and procedurally more complicated) replacement of level crossings with fly-over solutions.

The following safety-enhancing measures/methods may be classed as the spearheads of the proposed new Dutch level crossings policy:

- preventing "second train" incidents. These occur mainly at level crossings with automatic flashing light installations, but also at automatic half-barrier ones, and are caused by vehicles driving onto the level crossing after one train has passed while the continued red lights indicate that a second train is approaching;
- making "slalom driving", that is, driving around the descending or fully descended barriers, far more difficult if not impossible;
- augmenting the visibility/audibility of existing types of protection;
- developing new types of protection, e.g. complete closure by means of automatic half-barriers;
- supporting the above methods: intensify the traffic education of road users, aiming particularly at level crossing behaviour and the potential dangers of wrong actions;
- converting the most hazardous automatic flashing light installations to automatic half-barriers. The safety return on this measure would be of a magnitude such that the calculated increase in the number of victims as a result of Rail 21 (higher speed and more trains) would be virtually entirely compensated;
- converting unprotected level crossings on 160 routes to protected level crossings with automatic flashing light installations.

From the graphically represented relationship between methods, costs and risk reduction, it may be seen which results each method could achieve (fig.12). It is clear that the large risk reduction in the steep part of the graph may be attained against relatively low expenditure and also that the costs involved in further decreasing the risk will gradually rise.
Given the contrasting targets, methods and prior conditions, the appropriate management now has the task of choosing a good mix (fig.11). The freedom to choose is rather limited, though, as inseparable relationships exist between the three aspects which determine the policy. The relationships are fixed due to NS having selected the following strategy of managing the level crossings risk: begin with those investments which will have the highest safety return.

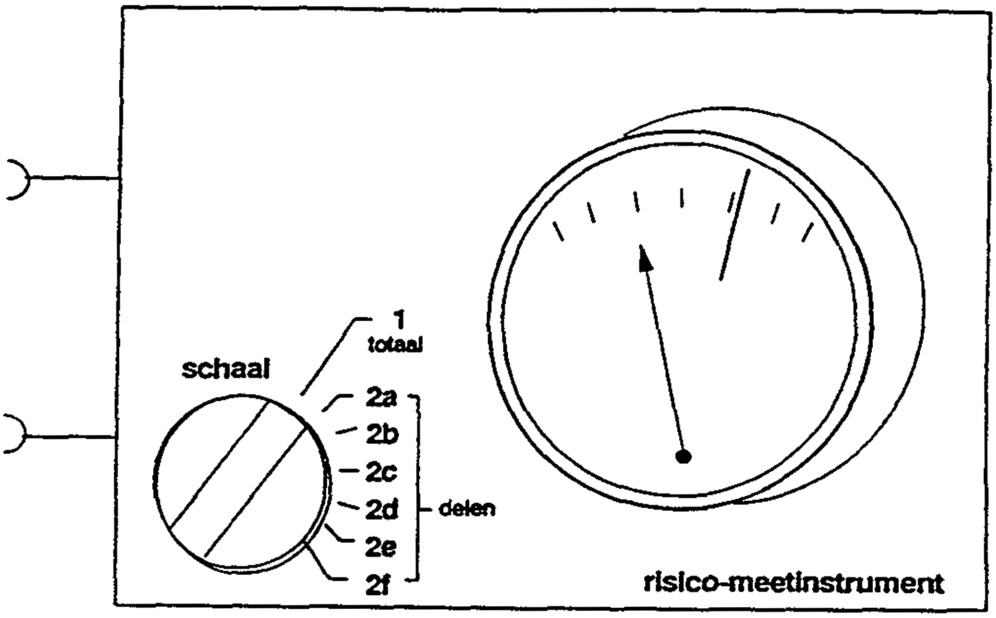


Fig. 13 *Schematic representation of the risk yardstick*
This instrument has an overall scale and scales for sub-riskaspects

METHODS of limiting the sequential risk in case of a collision

The SAVE study has drawn attention to the derailing risk. From analyses, it has become apparent that the IC 3 "front runner" is five times more likely to derail than average, other NS stock. It is therefore important that NS initiates efforts to reduce the likelihood of railway stock derailing.

The prime methods distinguished concern provisions which prevent (parts of) vehicles ending up under the bogie (fit track clearers) and/or increase axle pressure, whereby it becomes less likely that the train is lifted off the tracks. These measures do not form an immediate part of a level crossings policy but are, to a large degree, related to it. After all, the envisaged effect will have a direct influence on the number of potential victims inside a train in case of an accident at a level crossing, as well as on the associated company (safety) image.

Risk management of level crossings risk (fig.13)

Risk management means planning to control risks. To be able to draw up plans and to take risk reducing measures with respect to level crossings, the following aspects must have been researched and be known as thoroughly as possible:

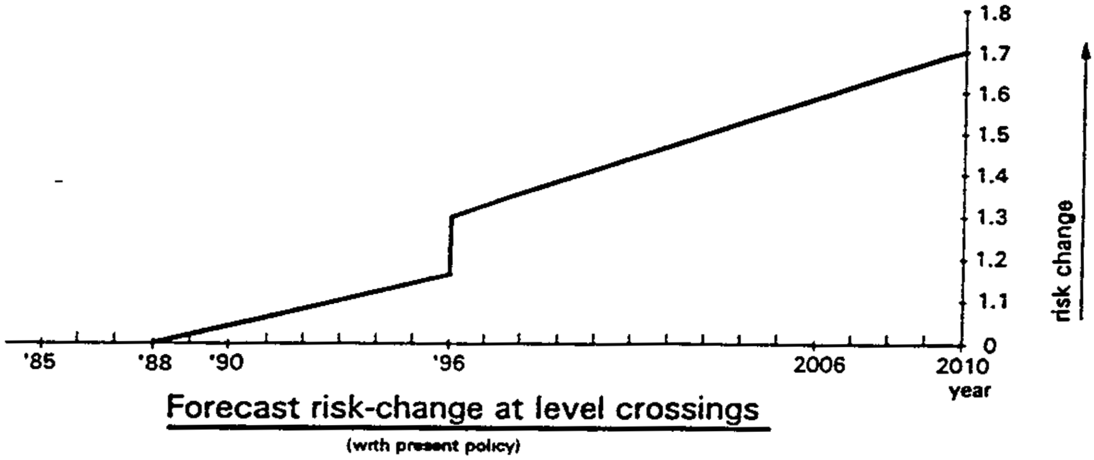
- know the risks and their causes
- know to what extent the causes contribute to the total
- be able to prioritize
- be able to predict the effects of measures considered
- be able to evaluate and, if need be, adjust measures in practice

The risk of incidents at level crossings is not a single entity. Various separate risks are involved, each with entirely different consequences and therefore entirely different evaluations:

- large chance of one or more victims;
- operating disruption;
- damaged image;
- chance of derailing and the associated risk of large sequential accidents, possibly a real train disaster;
- the chance of a dangerous substances or high speed train being involved.

To allow the most effective methods to be determined, a risk management tool is developed. A large number of physical characteristics of existing level crossings are gathered together and these are then probed against the number and circumstances of any collisions that took place on them. In doing so, a method evolves through which (any common) inadequacies of materially unsafe level crossings can be pinpointed. It is not anticipated, however, that such characteristics can be detected for all level crossings on which collisions have taken place. Collisions also happen by sheer coincidence.

This risk management tool, it is expected, will also allow level crossings to be selected on which, as yet, no or few incidents have occurred but which nevertheless potentially pose an increased risk. Through specific, preventive measures, it could be precluded that such a level crossing still reveal its unsafe nature in the future.



Assumptions:
- No new level crossing policy
- Constand amount of level crossings (= 1991)
- Increase of number of trains in 1996 because of tri-trainsystem
- After 1996 a speed increase to 160 km/h

Fig. 14 Forecast risk change without new level crossings policy

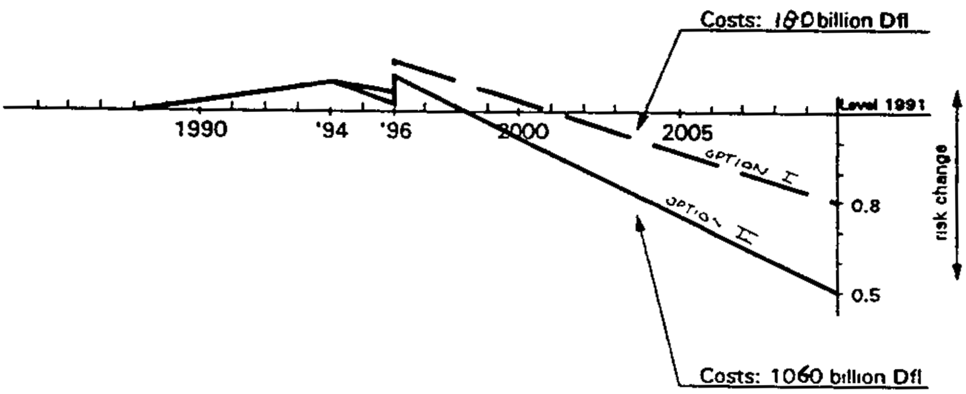


Fig. 15 Forecast risk change with new level crossings policy

As a yardstick for the level crossings risk to be accepted, the annually permissible maximum number of collisions may be used. Targeting the number of collisions is preferable to the number of victims as the number of victims depends to a large degree on arbitrary factors, such as, for example, the number of passengers in the colliding vehicle.
We expect the database for the risk yardstick to be ready by the end of 1993 so that the first analyses may be conducted.

Proposed policy and financing

To bring about a reduction in the number of collisions at level crossings, systematic investment in level crossings is needed. The size of the required amount is connected with the degree of the risk reduction targeted and the time scale in which this is to take place.
Within the proposed level crossings policy, three kinds of projects may be distinguished:

1. Construction of approximately 100 fly-over junctions for routes with more than 3 tracks where train travel speeds will exceed 160 km/hour. This policy course of action had already been laid down in the current Dutch level crossings policy. The costs are estimated at around Dfl. 1400 million. Implementing this particular action will be spread out over the entire realization period for Rail 21, i.e. up to the year 2010. Inspite of this policy the risk will grow with about 70% (fig.14)
2. One of the prior conditions of the new level crossings policy is that unprotected level crossings are no longer allowable at speeds exceeding 140 km/hour. Conversion to crossings with automatic flashing light installations, or abolishing the crossing altogether, will then be necessary. This entails some 200 unprotected level crossings being converted or abolished. Estimated cost Dfl. 41 million. Implementation of this project must keep pace with the introduction of the new train speed of 160 km/hour.
3. To be able to factually translate the level crossings policy into a level crossings risk policy requires a long range plan (along with a corresponding annual budget) for the execution of risk-limiting measures. The size of the budget is directly dependent on the degree of the risk reduction targeted and the time scale in which things are to take place. Two scenarios have been detailed, within which all kinds of variations are possible (fig.15).
   (The cheaper) Option I will cost about Dfl. 180 million and, by the year 2010, will result in a risk reduction of 33 victims p.a. compared to the situation that the current level crossings policy should be maintained. One feature of this option is that safety-enhancing methods will be used in the technology and lay-out of the level crossings. The first step towards effecting this scenario, converting 200 accident prone automatic flashing light installations into automatic half-barrier systems, has already been taken. Costs approx. Dfl. 60 million. Risk reduction as compared to 2010 following realization of Rail 21 will be about 24 casualties per annum.

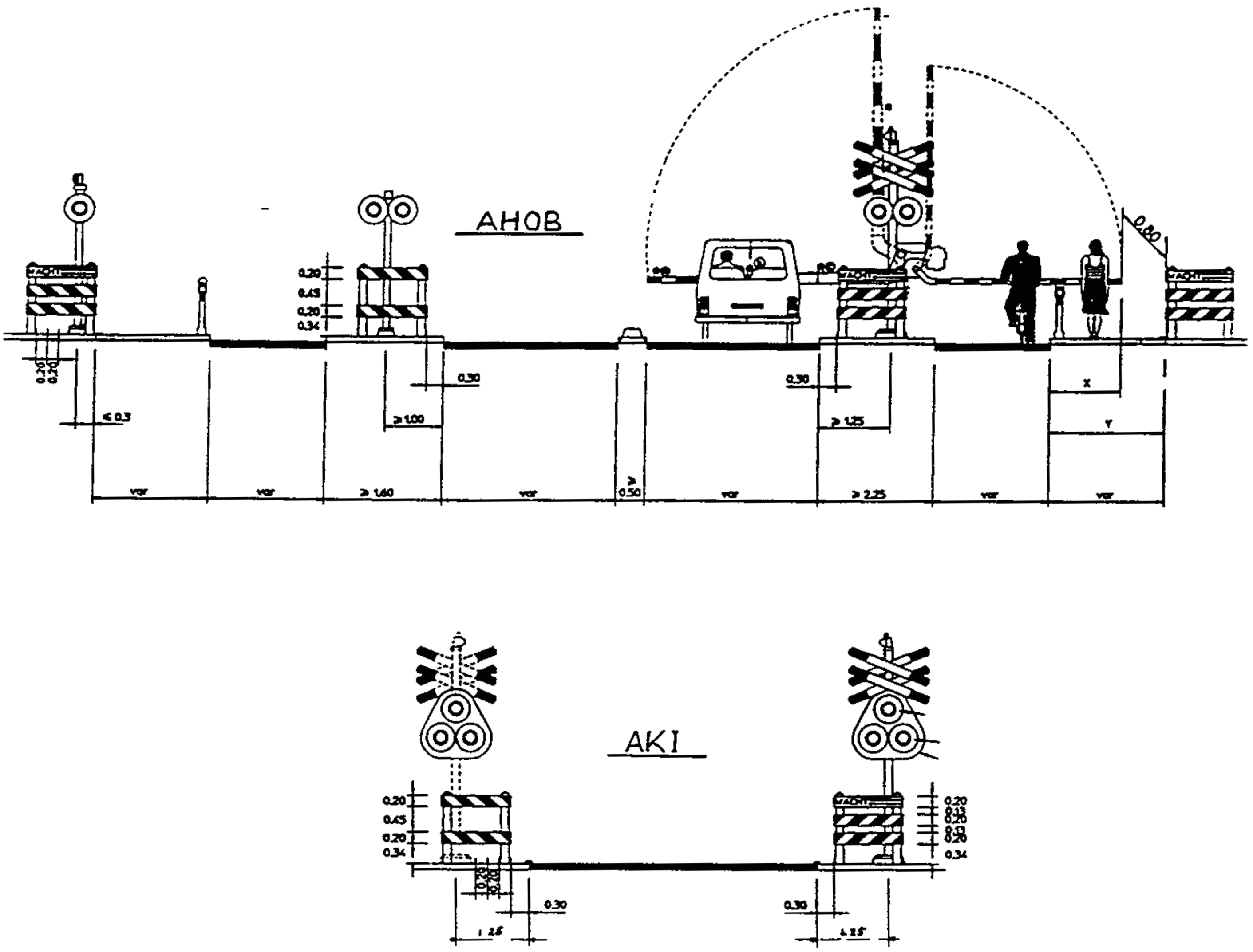


Fig. 16 *Level crossing types in the Netherland*

Option II will cost Dfl. 1060 million and, by the year 2010, will result in a risk reduction of some 55 victims p.a. compared to the situation that the current level crossings policy should be maintained. This option contains the measures of Option I as well as conversion of 50 materially unsafe automatic half-barrier level crossings into fly-over junctions. A cheaper alternative would lie in a (yet to be developed) type of level crossing which would close completely and automatically.

Epilogue and integration of the "ingredients"

The new level crossings policy should provide both direction and firm answers in the entirely new study field of risk increases, i.e. when is a risk acceptable, which measures may be taken, how should these safety-enhancing measures be financed, etc. It will no longer be the level crossing itself which will be at the heart of the issue, but rather the level crossing risk.

It is self-evident that such a re-orientation and reformulation of the policy cannot be plucked out of the blue but requires clear analysis of the risks as well as a learning process. The new policy will no longer primarily recognize a technological target, instead, it will formulate a risk target and the level crossings risk is far from being technological. This target carries an emotional charge which is directly related to the highly commercial "money", because money can take away the risk. There is no need for people to die on level crossings, provided money is made available to replace the level crossings with fly-over junctions. The price ticket dangling from this proposal is estimated to read Dfl. 15 to 20 billion. Which is an awful lot of money for the prevention of the social risk of 50 to 80 casualties a year.

The nation's mobility is still growing. Mobility costs money. Greater mobility is accompanied by a greater risk of incidents and accidents. Whether or not a risk level is acceptable is not determined by NS. Rather, it will be a social/political decision. The public transport company NS should not need to answer all by itself for the risk changes at level crossings resulting from the changes due to Rail 21. NS would not even be capable of doing so all by itself. The question of which target to adopt and how to pay for that target to be realized should first and foremost be answered by society and, therefore, by politicians. The target should be formulated such that all safety risks in (public) transport are integrally considered. NS shoulders the task of indicating by which methods the level crossings risk may best be reduced at as low a cost as possible. After all, risks are part of life and of the society we live in, and the money needed to decrease the risks is scarce and can only be spent once ...

The biggest merit of the SAVE investigation is that a risk model has been developed which enables insight into the consequences of risk changes at level crossings and couples these to methods and sums of money needed to manage this risk.

The assumptions used in the model may be disputed to some extent but do not render the model any less valuable. The calculation model has been decisive in reformulating the new level crossings policy.

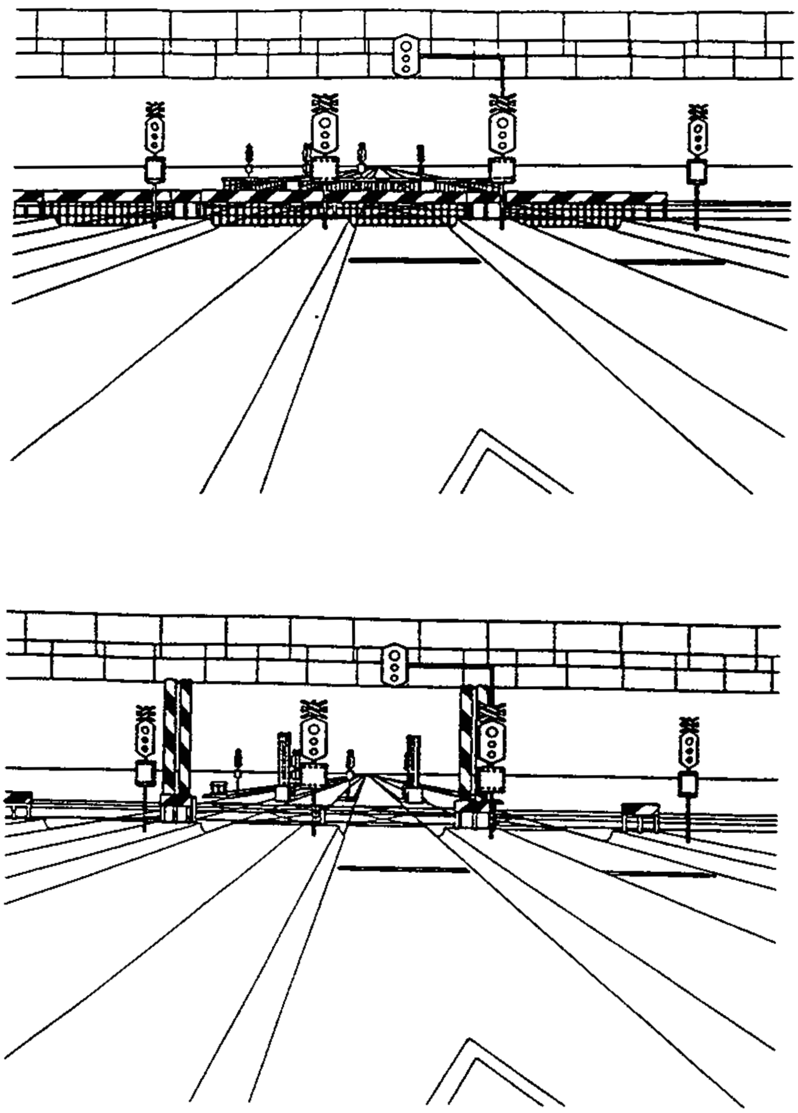


Fig. 17 *Result of an ergonomic study, to create a level crossing with a minimum accident risk; a full barrier crossing*

Naturally, NS too aims at abolishing all level crossings. Formulating a target, however, is a useless exercise unless the target is feasible and viable. Abolishing all level crossings is not. This luxury cannot be realized within the foreseeable future.
It is feasible, though, to reduce the average incident risk at existing level crossings to a considerable degree by implementing specific safety-enhancing measures. NS's strategy therefore aims to use any available money as effectively as possible.

The new level crossings policy, as has been described above, has been submitted to the Minister of Transport. The government have taken a positive view of the risk policy for level crossings. The policy provided the Minister of Transport with one more impetus to begin to formulate an integral safety policy for Netherlands Railways and to include in it a direct connection with other modes of transport. The Minister is expected to make the government's position known in 1994. In the meantime, however, work has begun on realizing the new level crossings policy - 200 unsafe crossings with automatic flashing light installations will have been converted into automatic half-barrier systems by the year 2001.

In short, NS intends to apply the following policy spearheads in the next few years:

Prevent collisions;	• Deal with materially unsafe level crossings; convert automatic flashing light installations into automatic half-barrier systems (fig 16), convert the latter into either free passage or full barrier crossings (fig.17)
	• Abolish or protect unprotected level crossings on 160 routes
Tackle driving behaviour;	• prevent second collisions
	• prevent slalom driving
	• educate and provide information
Limit the consequences of any collisions;	• Limit the risk of a train derailing by adapting stock

International Rail Safety Conference

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9334

Kurt Nolte

Safety of high speed railway tunnels German experiences of planning and realisation of safety measures

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

SAFETY OF HIGH SPEED RAILWAY TUNNELS GERMAN EXPERIENCES OF PLANNING AND REALIZATION OF SAFETY MEASURES

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THE SAFETY OF HIGH-SPEED RAILWAY TUNNELS

GERMAN EXPERIENCE OF PLANNING AND REALISATION OF SAFETY MEASURES

presented by Kurt Nolte in ANGERS, 26. - 28.10.1993,

on the INTERNATIONAL RAILWAY SAFETY SEMINAR

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Unfortunately, it still seems utopian to obtain a generally approved scale for adequate safety measures.

THE PROBLEM, EXPERT REPORT

To speak about 'The Safety of high-speed railway tunnels' is, from a German point of view, a view from yesterday to tomorrow. Since 1991 we have been running two lines and new lines are planned (Chart 1).
Safety measures can be developed from (1) single accidents, (2) statistical data of a longer term and (3) research. I will talk about the last one: research with the experience in theory and practice.
Safety for passengers in railway tunnels is an experience of more than one and a half centuries. To go by train is safer than to go by car. Where is the problem ?
Reflections of railway experts and scientists have come to the conclusion that new lines are safer than other lines despite the maximum speed of 250 km/h. But: the share of tunnels is about 35 % and an accident in a tunnel although with minor probability could cause greater damage.
Experience shows that tunnels are by no means less safe than other railway sections - on the contrary; inside a tunnel the trains are protected from a variety of conceivable dangers like snow or storm. However, if a train comes to a halt inside a longer tunnel due to fire and the intervention of fire-fighting brigades and rescue services should be required, problems might arise. The place of the accident lies in unaccessible points where the high standard of public rescue is not effective. The German Railways were aware of this fact at a very early stage and has commissioned the Zurich based Engineering Company Basler & Hofmann (now: Ernst Basler&Partner AG, Zollikerstr. 65, CH-8702 Zollikon) to analyse the complexity of this correlation in an expert report on safety.
The expert report is based on a safety model which was developed over a period of 15 years, and which was further developed for the tunnels of the high-speed lines based on the following essential elements:
(1) Elaboration of quantitative risk parameters as a measure of safety,
(2) Risk analysis,
(3) Planning of safety measures on the basis of cost/benefit considerations and
(4) Risk assessment for the determination of the required safety standard.
Let me go into the particulars of the risk analysis and later on into cost/benefit considerations.

RISK ANALYSIS; INDIVIDUAL RISK, COLLECTIVE RISK, AVERSION FACTOR

In order to assess the risks of a technical system it is required that all accidental events are investigated with regard to the probability of the event and its consequences. To measure the consequences in the railway problem, in the expert report the number of fatalities was used. Of course, there is other damage such as injuries, material damage and so on. However, for simplicity reasons, they had to use the number of fatalities as a proxy attribute to measure all damage. This risk measure is not sufficient to cover the whole problem.
In the safety model, a distinction is made between three different points of view, namely the individual who is exposed to a risk, the society and the company or agency which is reponsible for a hazardous activity.
This can be illustrated with the example of a dam break risk. Each person below the dam has a certain annual probability of being killed by a dam break. These

probabilities, called the individual risks, are plotted in a decreasing order here (Chart 2).
Besides the individual risk, society is concerned with the expected number of victims per year among the entire downstream population. This is simply the sum of all individual risks and is represented by the area below the graph of chart 2. This measure is called the collective risk which we talked about before; it represents the statistical damage expectation.
A third point has to be taken into account. Experience has shown that a company or agency may be faced with special problems caused by extremely severe accidents. Such accidents can not only merely affect its economic basis but also its image which may indirectly endanger a company's existence. After a catastrophe in a tunnel it could be possible that passengers simply refuse to use high-speed trains. Either way, this would eventually mean that the new system no longer could be operated with any profit.
Therefore definition of the collective risk is extended. The new measure, called the perceived collective risk, emphasizes the importance of high-consequence events. Well, the weighting factors are commonly known as risk aversion factors.
On the chart 3 you can see the factors which were used in the railway study and - as a further example - those used in explosive safety. These functions cannot be determined in an objective way. Rather, they belong to the risk appraisal part and involve value judgements.

PLANNING OF SAFETY MEASURES; COST/BENEFIT RELATION

Although the aim of some people working in safety is 'zero risk', we know that there is always a remaining risk. Our question is: which measures have low costs and high risk reduction so that the money is spent efficiently.
Altogether about 100 safety measures were investigated and estimated in costs and possible risk reduction. Finally, all safety measures and their combinations were plotted in a risk/cost-diagram (Chart 4).
You will realize that only the measures on the optimal line are of further interest as only those measures achieve the maximal risk reduction for a given amount of money.

RESULT OF THE EXPERT REPORT AND FURTHER DEVELOPMENT TO THE SAFETY CONCEPT

The result obtained mainly consisted of organisational preparations regarding the existing and external rescue measures. For the occurrence of a major event, which may be highly unlikely, only moderate expenses are considered acceptable.
This result has been further developed by experts of the German Railways striving for a concrete realization.
The set of measures to be taken comprises the following four components:
(1) measures designed to prevent accidents,
(2) measures designed to restrict the extent of accidents (Chart 5),
(3) self-rescue measures (Chart 6) and
(4) external rescue measures (Chart 7).

The measures designed to prevent accidents serve the strategic aim of taking preventive steps to exclude conceivable dangers and they are mainly based on the planning of general safety measures.
From the safety point of view, the most important element of the measures designed to restrict the extent of accidents consists in the uncompromising introduction of the 'emergency braking override' on all passenger trains of the high-speed lines. The 'emergency braking override' is a special piece of equipment for neutralising an emergency brake, pulled by a passenger. So the engine driver can avoid a stop within the tunnel.
The concrete arrangements concerning the two components self rescue measures and external rescue measures are closely related to the kind of rescue services. Self rescue and external rescue measures take account of the situation arising when the extent-reducing measures fail to achieve the desired effect and passengers have to be evacuated from a burning train stuck inside the tunnel. Under theses circumstances the help of fire brigades and rescue services will be needed.

Problems Arising During the Elaboration of the Concept

General protection against fire as well as general emergency prevention lie in the responsibility of the Federal States. In case of emergency, the Federal Railway relies on the public support of the fire brigades and the rescue services.
In view of this situation, a special workshop Federal Railway/Federal States began in-depth discussions regarding the safety concept for the tunnels on the high-speed lines.

- Based on the expert report compiled by Basler & Hofmann the German Federal Railways started from the assumption that with respect to the self rescue and the assisted rescue measures, commensuration to other safety measures like level crossing safety has to be maintained and an unequal weighting in the overall railway safety system can not be tolerated in view of the unlikelihood of these measures to come into application.
- For their part, the state government declared themselves in favour of a maximum rescue potential for persons involved, irrespective of the likelihood of an accident.

In view of these controversial opinions it is not to be expected that a perfect consensus will be achieved. Nevertheless, the workshop consultations had a fruitful impact on a variety of design concepts amongst the divisions of the German Railways; especially a detailed assisted rescue concept was established in close cooperation.
A uniform realisation of the concept agreed upon with the fire protection experts of the individual states was, however, aggravated by the fact that some of the fire brigades concerned developed divergent ideas regarding their strategy for action.

Realization of the Essential Components of the Concept

Let me explain the realization of the <u>components</u> shown in Chart 6.

<u>Emergency braking override</u>

Due to the robust construction of railway vehicles it can be taken for granted that the train remains in running order even in a case of a fully developed fire. On the other hand, the emergency brake systems allow passengers to cause an uncontrolled stoppage of the train. Passengers might possibly bring a train to a halt inside a tunnel thus taking action which counteracts the objectives of the safety concept strategy.
In order to rule out such situations, passenger trains on high-speed lines will be equipped with facilities overriding passenger-induced emergency braking.

Measures taken by the train personnel
A uniform action scheme was developed which as 'self rescue concept' is binding to the train personnel.

Tunnel lighting
The lighting in tunnels with a length of more than 1 000 m consists of individual lamps installed at a distance of 44 m.

Escape Routes
Inside the tunnels of the high-speed lines, escape paths approximately 1.7 m wide are available on both sides.

Marking of Escape routes
The escape routes are marked by standard pictograms in general use.

Emergency telephones
Inside the tunnel telephones are to be found on both sides every 600 m, which allow a connection with the responsible station inspector without dialling.

Emergency exits
Emergency exits allow the passengers to escape from the tunnel to a 'safe area', in order to evade the danger in a smoke-filled tunnel. Concerning the significance of emergency exits in the tunnels of the high-speed lines, the entire scope of decisive safety measures was investigated.
Considering a number of up to 500 people per train, a critical time for escape of 30 min and an average speed of escape about 60 m/min, tunnels with a length of more than 3 km will pe provided with emergency exits according to the rescue benefit and commensurate considerations. Furthermore the tunnels were built with slope only in one direction. So there is natural ventilation in the tunnel and there is no valley where liquid or gas can collect.

External rescue measures
For an efficient external rescue action, a rescue concept was developed together with the experts of the individual states.

Each of six rescue trains consists of one equipment coach, one coach carrying fire extinguishing material, furthermore one ambulance coach and two transport coaches using gastight containers. For traction purposes, use is made of two diesel engines with the option to install a shuttle service between the interior of a tunnel and an accessible place outside. The railway personnel consists only of the two locomotive drivers. All other personnel including the operational managers come from the fire brigade and the rescue services.

COSTS

The overall costs for the safety precautions amount to

- approx 60 x 10^6 DM for the special tunnel equipment and
- approx 120 x 10^6 DM for the rescue trains including facilities for the trains to be stationed.

In addition a rescue train requires another 2 x 10^6 DM per year for stand-by duties, maintenance and regular training of the rescue teams.
Consequently along the high-speed line, the costs for safety precautions only aiming at minimising the risk of fire inside passenger trains amount to about 0.8 x 10^6 DM for a tunnel length of 1 000 m.

CONSEQUENCES ON THE OPERATING PROGRAM OF THE HIGH-SPEED LINES

For the two high-speed lines, operations involving fast passenger and freight trains have been envisaged. In order to minimise the risk for trains, the running hours for passenger trains and freight trains have largely been separated, that means passenger trains are run during the day time while freight trains are run at night. This implies a considerable restriction regarding competitive, high-quality transport performance.
With respect to passenger traffic the usage of passenger carriages is considerably inspired by the strict rule that .these trains have to be equipped with emergency braking override, which is especially problematic regarding international long-distance trains.

CONSEQUENCES FOR FUTURE HIGH-SPEED LINES

The concepts for future high-speed lines (see Chart 1) have been set up in such a way that by means of appropriate realization and structural design of the tracks, the efforts for special safety measures inside tunnels will be restricted.
Along certain lines only rapid passenger traffic is envisaged from the very beginning, allowing a minimisation of tunnel sections by accepting greater gradients thus improving adaptation to topographic conditions.
For each line section with tunnels - especially lines with passenger and freight traffic - alternative external rescue concepts with or without rescue trains are being considered. If possible from the routing and constructional point of view, two parallel single-track tunnels are to be constructed instead of twin-track tunnels.
These tunnels are to be designed in such a way that they are accessible with road vehicles and that with correspondingly arranged cross passages, one tunnel can be used both as escape and rescue tunnel. Even in locations where twin-track tunnels are inevitable, efforts are being made to do without rescue trains by providing emergency exits as well as fire fighting water and radio equipment.
Before drawing to a close, may I be allowed the critical remark that with regard to safety measures the relation between benefits and costs may not be totally ignored.

It can not be in the public interest that the competiveness of an enterprise like the German Railways is put at a disadvantage compared to road traffic with its considerably greater traffic risk.

CONCLUSIONS

High-speed railway lines with a great proportion of tunnels require special examinations of safety in case of fire. This is caused by the potentially greater extent of damage as a consequence of an accident within tunnels in comparison to an open line.
The decisive contribution to reduce the risks is the emergency braking override for passenger trains.
Especially expensive are the investments for self rescue and external rescue. Furthermore regular training is very important to guarantee the efficiency of the rescue system.
The commensuration of appropriate measures has been estimated differently in view of the railway on the one hand and the public rescue services on the other hand. Therefore the public rescue services should participate at an early stage of planning new lines. Jointly examing the required measures, the generally high level of railway safety should be emphasized.
Unfortunately, it still seems utopian to obtain a generally approved scale for adequate safety measures.

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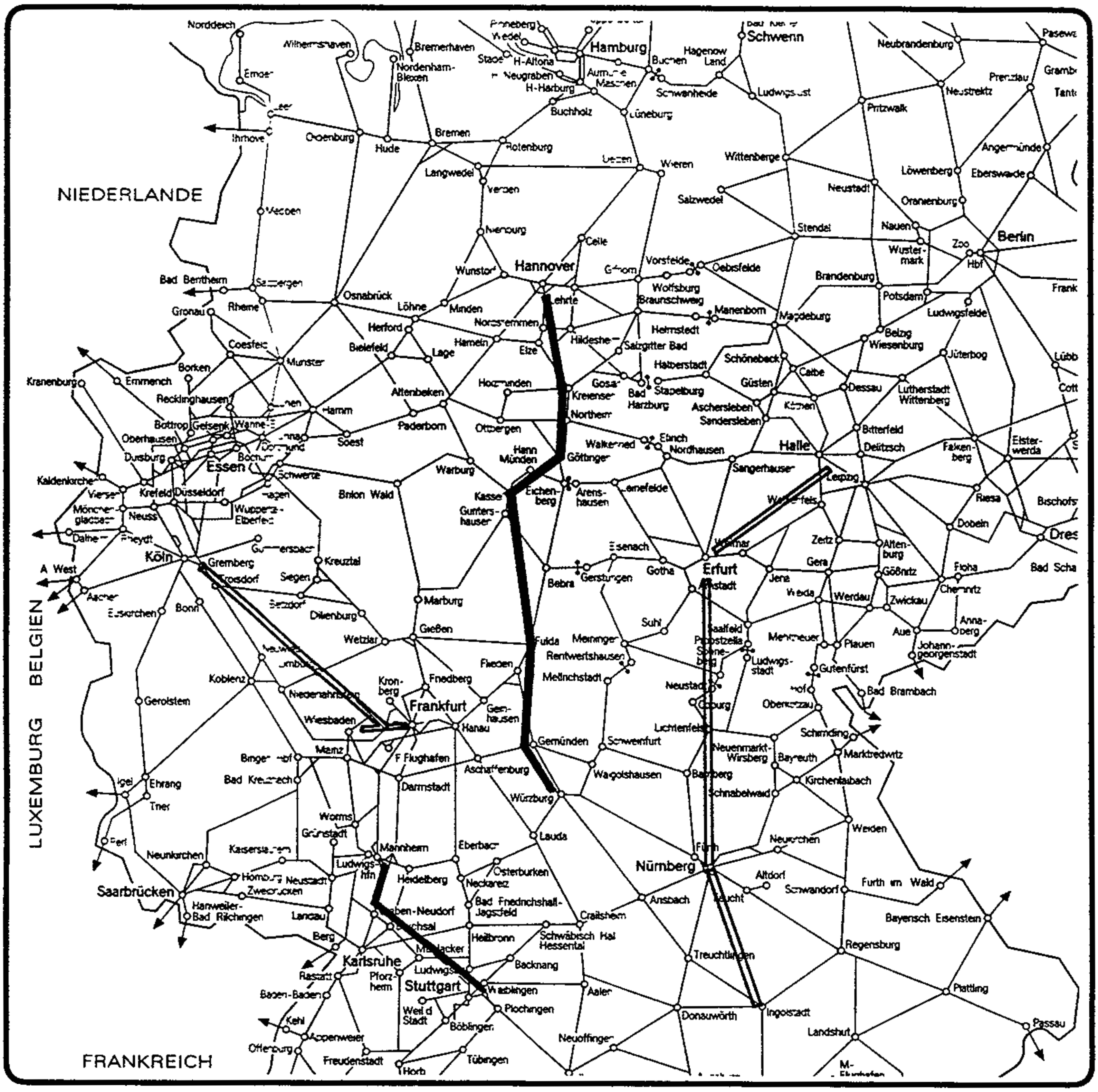

Existing and planned high-speed lines with tunnels **Chart 1**

633{Bas}SFTY938.WPS/1 International Railway Safety Seminar, Angers, 26.-28.10.1993

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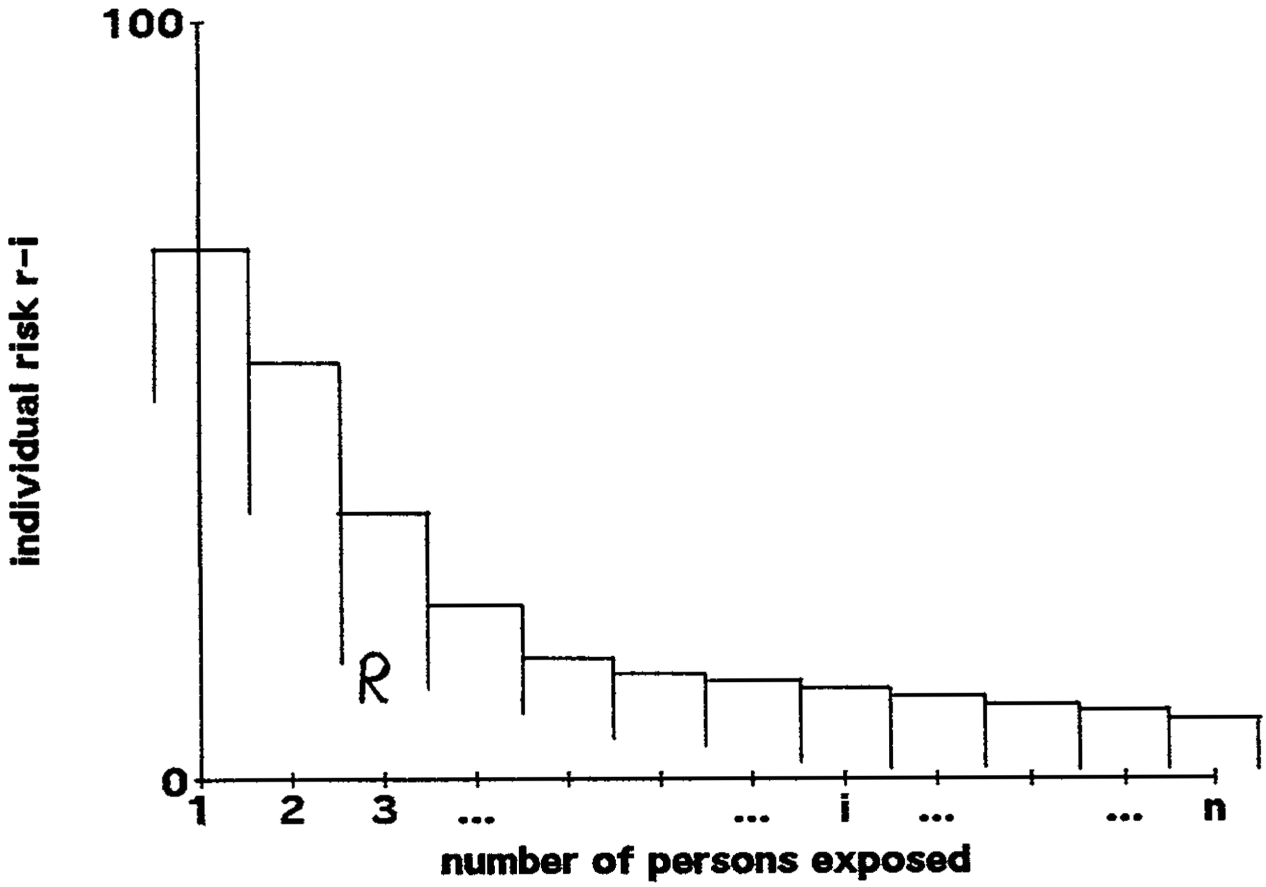

The collective risk R is the sum of all individual risks r_i of the persons exposed

Individual risk and collective risk — Chart 2

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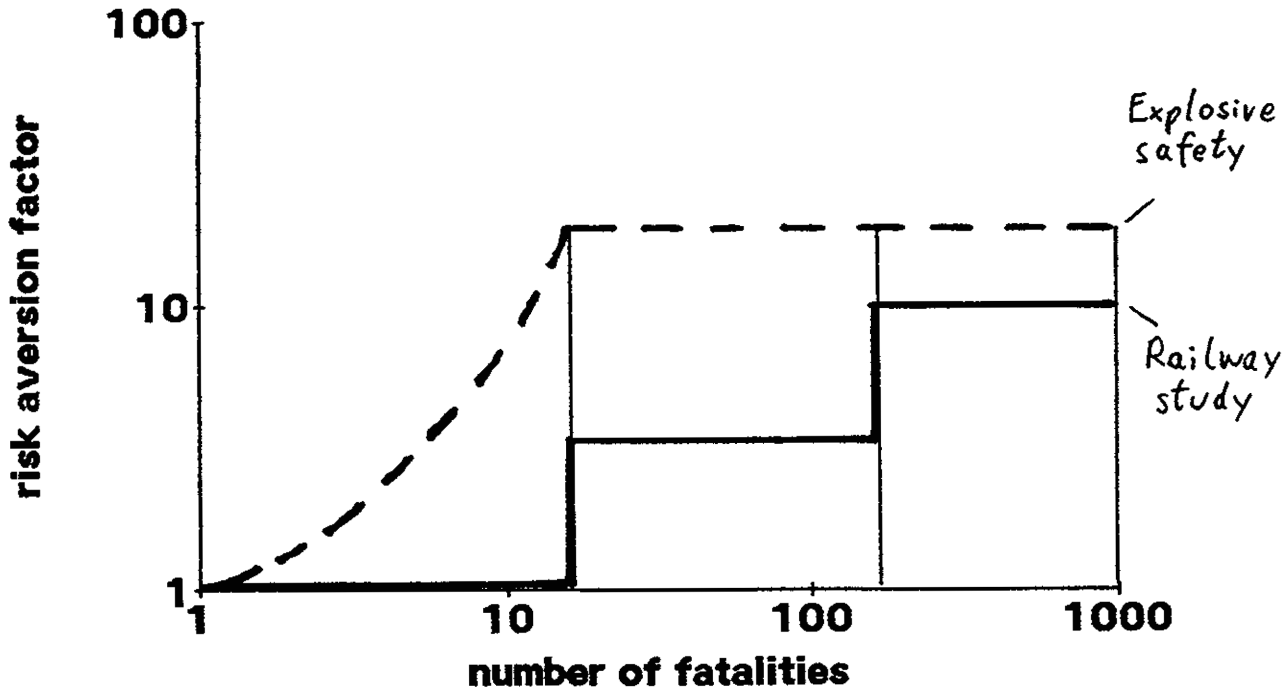
Street:		Railway catastrophe:
every year 1,000 accidents with 1 fatality		once a year 1 accident with 1,000 fatalities
1,000 * 1	is not equal	1 * 1,000



Examples of risk aversion functions **Chart 3**

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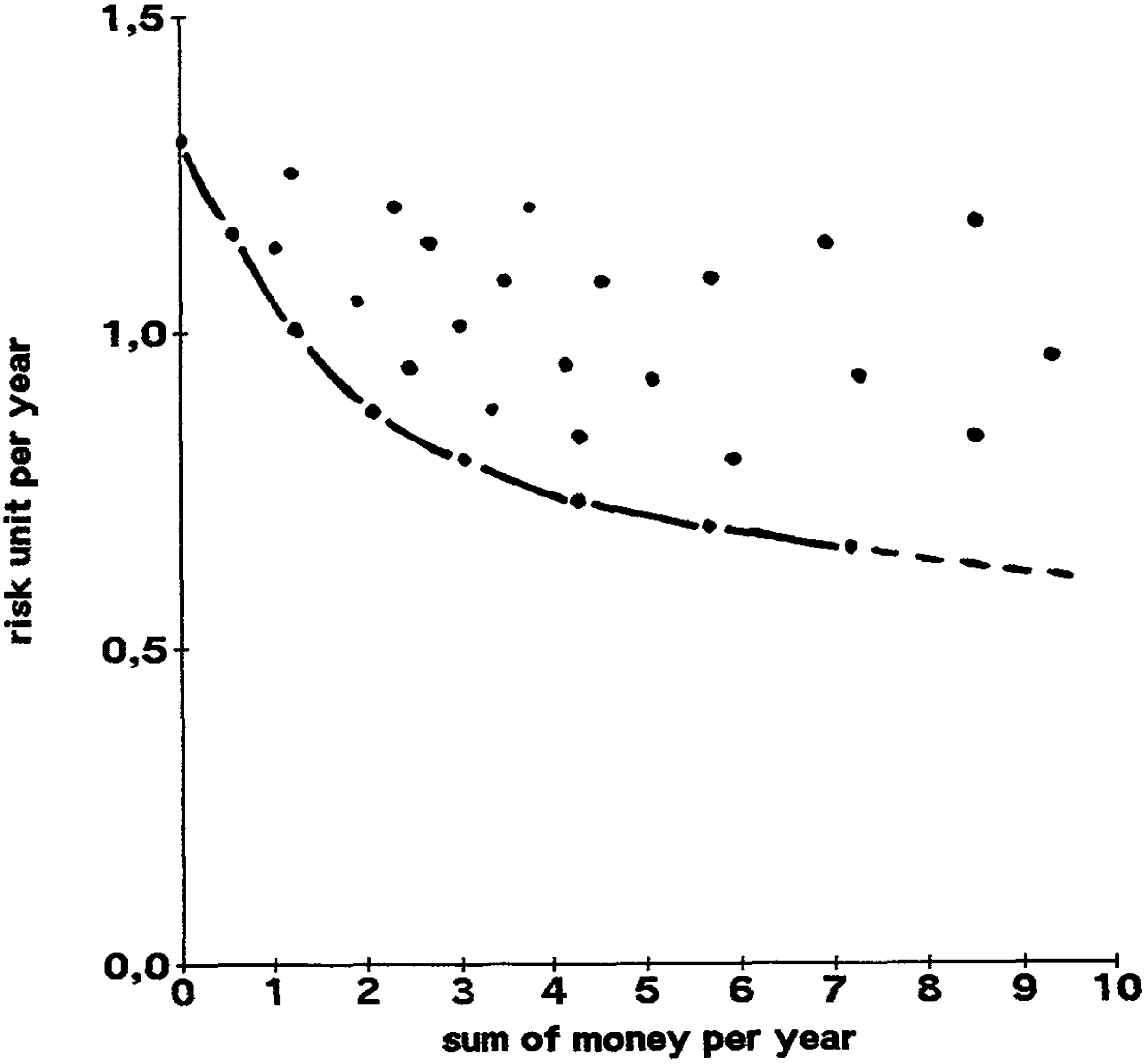

Risk / cost - diagram

Chart 4

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MEASURES DESIGNED TO RESTRICT THE EXTENT OF ACCIDENTS

- ▷ EMERGENCY BRAKING OVERRIDE
- ▷ MAINTAINING BURNING COACHES IN RUNNING ORDER
- ▷ FIRE-PROOF INSTALLATION OF CONTROL LINES WITHIN THE COACHES
- ▷ EQUIPMENT OF COACHES WITH EFFICIENT FIRE EXTINGUISHERS

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Self rescue measures

- Self rescue concept
- Training of operating personnel
- Tunnel lighting
- Escape routes
- Marking of escape routes
- Emergency telephones
- Emergency exits

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EXTERNAL RESCUE MEASURES

- ▷ TRANSPORT CAPACITY
- ▷ EASY ACCESS FOR RESCUE OPERATIONS
- ▷ ENERGY SUPPLY
- ▷ SUPPLY OF WATER FOR FIRE FIGHTING PURPOSES
- ▷ PROVISION OF WIRELESS COMMUNICATION EQUIPMENT
- ▷ FIRST AID FOR CASUALTIES
- ▷ RESCUE AREA WITH ACCESS ROADS
- ▷ SPECIAL INSTALLATIONS FOR FAST EARTHING OF CATENARIES

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9335

Bill Casley

Rail Safety Act, 24/9/93, New South Wales

Publisher
2000 International Rail Safety Conference

International Railway Safety

Seminar 1993

RAIL SAFETY ACT
24.09.1993
NEW SOUTH WALES

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NEW SOUTH WALES AUSTRALIA - DEPARTMENT OF TRANSPORT

NEW SOUTH WALES - RAIL SAFETY ACT, 1993

A paper for presentation to the International Railway Safety Seminar to be held in France, October 1993.

INTRODUCTION

The New South Wales, Australia, Rail Safety Act, 1993, which came into force on 24 September 1993, is the product of careful analysis of experience on both the international and domestic fronts of mechanisms to regulate the safety of rail operations. While it incorporates the best elements of existing regulatory regimes, it has been structured to avoid the large bureaucratic organisations, with their associated costs, which are often needed to administer similar regulatory schemes.

The impetus to develop this legislation did not come from any shortcoming in the maintenance of rail safety by the principal railway in New South Wales (the largest Government railway operation in Australia), the State Rail Authority. Rather, it was prompted by the substantial change and growth occurring within the rail industry in State and in Australia generally.

By way of background, the Government owned State Rail Authority (SRA) has enjoyed a virtual monopoly over public railway operations for nearly 140 years. However, developments over the last two years, which have been promoted and implemented by the Rail Policy and Regulation Division of the Department of Transport, headed by Mr John Walker, have seen this monopoly eroded with an increasing move to open access to the rail system. Some of these developments are:

- the establishment of a national freight carrier, the National Rail Corporation;
- the trend to establish commercial Short Lines from what were previously disused SRA lines;
- considerable growth in heritage train operators;
- the expansion of commercial railway systems such as the Zig Zag Tourist Railway, Silverton Tramways and Skitube;
- plans for a high speed, privately operated trains and negotiations underway with large companies for private freight railways; and
- proposals to evaluate the introduction of light railways in major metropolitan centres such as Sydney and Newcastle.

These factors meant that a number of rail operations were not subject to proper regulatory control. Attachment 1 details the site locations within NSW of the various rail operators.

In general, prior to the enactment of the Rail Safety Act, the safety of privately operated railways was covered mainly by the Occupational Health and Safety Act and the Shops, Factories and Industries Act. These Acts are primarily concerned with the workplace environment and were never intended to cater for the special aspects of rail safety, particularly in relation to operations, infrastructure or rolling stock.

In this environment, it was clear that the Government needed to act to ensure that adequate and independent regulation was developed to provide for the safe construction, operation and maintenance of railways within the State and the Rail Safety Act is the mechanism developed to achieve this objective.

The legislation is also a further step in implementing the Government's policy of separating regulatory functions from the operational activities of Government Agencies. In this respect, the Government is of the view that regulatory and operational functions should be separated so that operational agencies can concentrate on delivering services to their customers. At the same time, regulatory functions should be preferably undertaken by inner budget sector bodies which are sufficiently separate from operational activities to maintain a high degree of independence.

The enactment of this legislation has therefore established a significant landmark in the operation of railways in New South Wales. Furthermore, it has also established a national benchmark for similar legislation in other States throughout Australia. It is appropriate that such legislation should be initiated in New South Wales where that State's railways have long been associated with being a meaningful tool in the development and well-being of the State as well as being pivotal railways within the national railway scene.

OVERVIEW OF THE SCHEME

Under this legislation, any person or organisation wishing to operate a rail service in New South Wales will have to be accredited by the Director-General of the Department of Transport. Perhaps the most significant feature of the Act is that it is co-regulatory in nature. That is, it relies upon each railway developing its own benchmarks for safety performance, within the framework of generally accepted standards, against which the Government will monitor compliance.

As such, the Government will not necessarily be establishing new and highly prescriptive standards which all elements of the rail industry must adhere to. Rather, individual railways will be responsible for developing their own safety performance standards and submitting them to the Director-General of the Department of Transport for assessment. Where the Director-General is satisfied that the proposed standards will maintain the highest levels of safety then the organisation will be accredited.

This does not, of course, mean that safety standards will slip under the new scheme, but rather, it is significant because it recognises that railways with different operational characteristics should not all have to follow the same rigid standards, irrespective of the type of operation they are running. For example, a small, freight only railway operating on a short line which does not connect with any other main line should not necessarily have to operate to the same scope of safety standards as would apply to, for example, a suburban passenger network.

On the question of standards, of course, there will still be a clear need for railways seeking accreditation to adopt technical standards which are widely accepted as sufficient to maintain the safety of rail operations as accreditation will only be granted where the safety standards submitted by a railway can be demonstrated to ensure that the railway will be operated to accepted levels of safety.

These arrangements aim to cater for the public interest in matters of safety and, at the same time, provide operators with the scope to determine their own measures to pursue agreed levels of safety performance.

An integral part of the overall scheme is the requirements for railways to conduct investigations into any safety related incident and report the findings to the director-general. This further promotes the overall thrust of the legislation which aims at ensuring that railways take responsibility for maintaining the safety of their systems.

Also it removed the need for separate investigatory and regulatory agencies to be established, an approach which has been adopted in many other countries. As the railways themselves will be responsible for investigations, the Government will generally only investigate incidents where there are concerns about the thoroughness of a railway's own investigation, or the incident is serious enough to warrant independent investigation. This approach has the advantage of significantly restricting the resources required to administer the legislation and obviates the need to establish separate investigatory functions.

There are also requirements for a range of notifiable occurrences to be reported on a regular basis. This will enable the Government to monitor performance and step in where there appears to be a problem developing in a particular railway. These reporting requirements will also provide a means by which the magnitude and nature of rail safety issues can be more readily understood and measured.

BASIC ELEMENTS OF THE SCHEME

The Directorate of Rail Safety

The Act provides that the Director-General of the New South Wales Department of Transport is responsible for regulating the safety of all rail operations in the State. The Department of Transport is a separate organisation to all operational railways in the State, including the Government owned State Rail Authority, and this ensures the independence of the regulatory function.

In practice, the day to day administration of the legislation will be handled by a new unit which has been established within the Rail Policy and Regulation Division of the Department called the Directorate of Rail Safety. The Directorate will oversee the safety of all railways operating in New South Wales and reflect the best aspects of other similar schemes operating in Great Britain, Canada and the USA. Attachment 2 shows the position of the Directorate within the Department and its relationship with operating railways.

The Directorate will be predominantly staffed by persons with the necessary comprehensive expertise and depth of experience in the rail industry to properly assess safety standards submitted by applicants for accreditation. These officers will also conduct compliance audits, inspect railway operations and participate in inquiries into safety matters.

Provision has been made in the legislation for the secondment of appropriately qualified staff from the transport authorities. This ensures that the Directorate has adequate access to a pool of expertise.

Railways Covered by the Legislation

The provisions of the Act apply to all passenger and freight railways operating in the State on track with a gauge of 600 millimetres or more. This includes heavy rail, light rail, inclined rail, monorail and tramways. However, it does not apply to railways which are already adequately covered by existing legislation such as underground mining rail systems or amusement park rides such as the "big dipper" and "ghost train".

Owners/Operators

As an operator of rail services may not necessarily also own the track upon which it operates the legislation draws a distinction between the accreditation of an owner and an operator of a railway. A railway owner can be generally defined as the party who is responsible, whether by ownership, lease or other arrangements, for the construction and maintenance of the infrastructure and associated control systems of a railway, whilst a railway operator is the person or organisation which operates the railway and is responsible for the maintenance of the rolling stock. This does not prevent, however, one person or organisation becoming accredited as an owner and operator.

Accreditation

In assessing an application for accreditation to operate a railway, the Director-General may take into account all factors which are considered relevant in the circumstances, including:

- current departmental and government policy;
- the applicant's financial position;
- the applicant's competency and capacity to maintain and operate a railway in terms of financial, administrative and technical expertise;
- the suitability and appropriateness of infrastructure, rolling stock, signalling and safeworking systems;
- competency of safeworking staff; and
- availability of adequate staff and facilities (such as workshops and depots) to properly operate and maintain the subject railway.

Private Railway Sidings

Throughout the State there are a large number of privately owned railway sidings. These are sections of track which are connected to a main rail line but are not necessarily owned by the main rail line owner. As some of these are no longer used it was not considered appropriate to provide blanket coverage of these sidings in the legislation. Rather, a discretion has been given to the owner of such a siding to elect whether they wish to maintain their access to an accredited main rail line or not. Should the owner decide to maintain the access, then it will be necessary to register the siding, on an annual basis, with the Director-General and no rail operator will be permitted to run services on an unregistered siding.

Where a siding has been registered, then any rail operator applying for accreditation to operate on that siding will be required to demonstrate that an appropriate agreement is in place for its maintenance to appropriate standards of safety. Where a siding has not been registered, then an accredited rail owner may apply to the Director-General to disconnect the siding from the rail line and, if approval is given, the rail owner can sever his/her association with the siding.

Railway Safety Workers

An essential feature of the accreditation process will be for owners and operators to ensure that railway employees performing railway safety work are adequately trained, are in receipt of appropriate certificates of competency and have the necessary health and fitness to undertake this work. Additionally they must ensure that such railway employees are not under the influence of alcohol or other drugs when reporting for duty or whilst on duty.

Consequently, this legislation extends the provisions of the Transport Administration Act, 1988, covering the drug and alcohol testing of SRA staff, to all accredited railways in NSW. Furthermore the Directorate of Rail Safety, as part of its independent role, will arrange random alcohol and drug tests of railway safety workers to ensure that railways are being operated and maintained safely. These are most likely to occur as part of the compliance auditing functions that the Directorate will undertake.

Penalties

To ensure that the safety of individual railways is properly monitored, the legislation provides that the Director-General, or a person properly authorised, may enter and inspect any property, premises or rolling stock forming part of a railway or its operation, for the purpose of inquiring into aspects of railway safety, railway operations or a railway accident. While compliance with the Act will generally be enforced through the suspension and/or cancellation of an owner or operator's accreditation, a range of penalties have been provided in the Act to ensure that appropriate sanctions exist to deter non-compliance with this important legislation.

The maximum penalty provided for is 12 months imprisonment and/or a fine of $250,000, in the case of a corporation (which must nominate a director or directors to be held responsible as part of its application), or imprisonment and a fine of $100,000 in any other case. It is not envisaged that the same person could be simultaneously charged with more than one offence.

The Director-General will also be able to vary any conditions or limitations attached to an accreditation, including imposing new conditions or limitations as well as granting exemptions or interim accreditations. Provision has been made for appeal to a court against the Director-General's decision not to grant an accreditation or to suspend and/or cancel an accreditation. As suspension or revocation of the SRA's accreditation may not be a viable punitive action in response to a breach of its accreditation, the Director-General is empowered to prosecute the Crown, subject to Ministerial approval.

If a corporation contravenes a provision of this Act, then each person who is a director of the corporation, or who is concerned with management, will be regarded as having contravened that provision, if the person wilfully authorised or permitted the contravention. Moreover, such a person will be able to be convicted as an individual, whether or not the corporation has been successfully prosecuted.

To provide sufficient time for the conduct of thorough field inspections and technical evaluations prior to the commencement of action for a breach of the provisions of this legislation, provision has been made for proceedings to be instituted up to two years after an alleged offence occurs.

Notifiable Occurrences

Provision has been made, in Schedule 2 of the Act, for owners and operators to give timely advice on a range of notifiable occurrences which may occur on their railway. This information will be used to establish a database which will be used for the regulation of railways. Similarly owners and operators will also be required to provide an annual safety report.

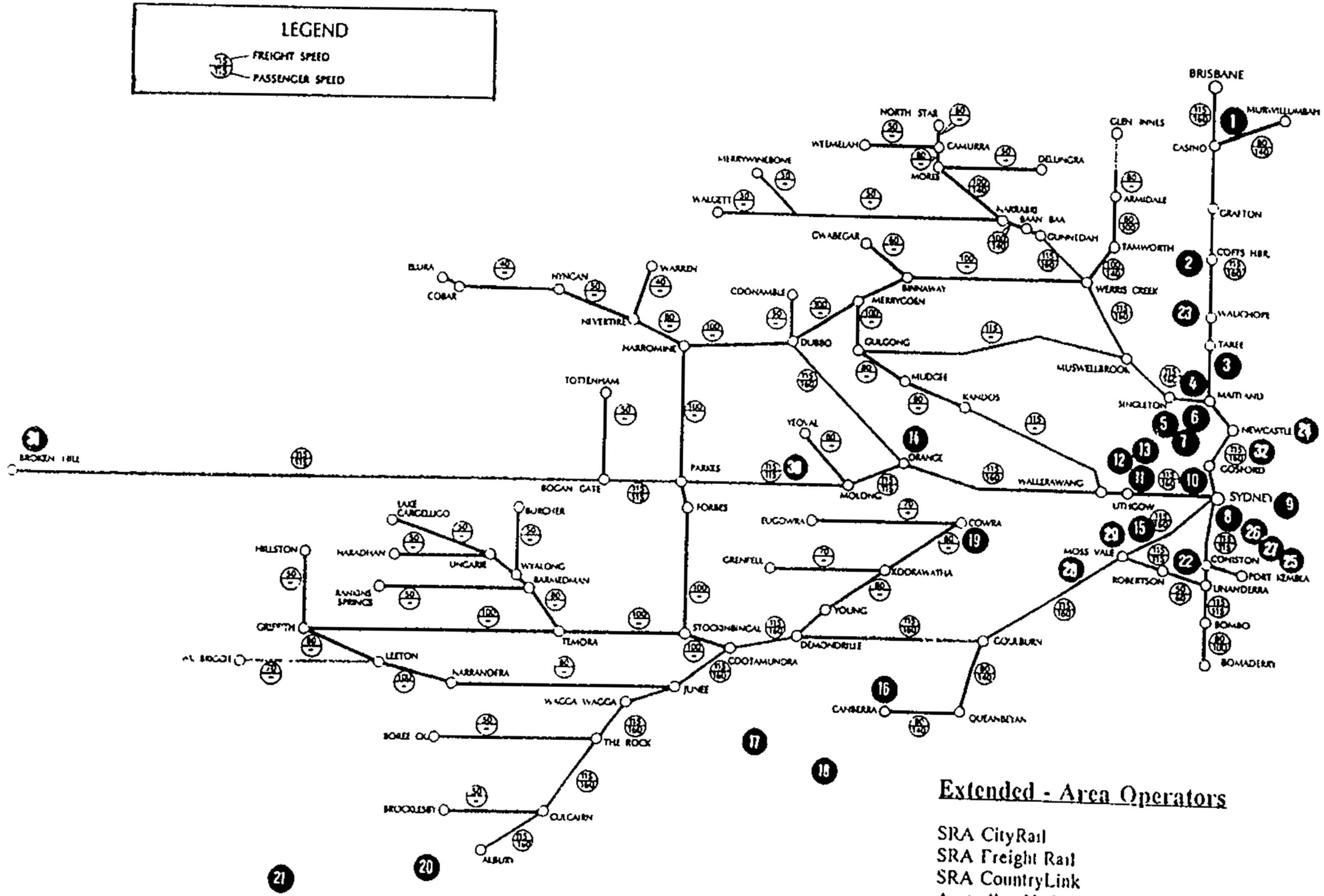
Fees

The legislation has negligible resource implications for the Government as the costs of its administration will be recovered through accreditation and annual fees. The Government recognises that these fees, because of the diversity of railway operators throughout the State, will vary substantially according to each individual railway. For this reason, accreditation and annual fees will be based on calculations which use established tonnage fee rates for commercial freight and passenger haulage. This means that applicants will need to provide performance details or projections of their railway.

To minimise the impact on heritage and/or small rail owners/operators, the accreditation and annual fees will be based on a sliding scale relating to units of rolling stock and/or per track kilometrage accredited for operation. This will ensure that smaller organisations are not faced with unreasonable fees. Details of the accreditation or annual fees payable, including minimum fees, will be published in the NSW Government Gazette, and will be payable prior to the granting of an accreditation or in the case of annual fees, prior to the commencement of the ensuing year.

W.S.CASLEY
Director,
Rail Safety
Directorate of Rail Safety
Rail Policy and Regulation Division
NSW Department of Transport
24 September 1993

ATTACHMENT 1



Local - Area Operators

1 Northern Rivers Scenic Railway
2 Dorrigo Steam Railway
3 Bulahdelah Logging Co Railway
4 Maitland Tramway Museum
5 Richmond Vale Railway
6 South Maitland Railway
7 Rothbury Riot Railway
8 Sydney Tramway Museum
9 Sydney Electric Train Society
10 Parramatta Park Railway
11 Zig-Zag Railway
12 Macquarie Valley Railway Society
13 Lithgow Mining Museum Railway
14 Central West Railway Pres Society
15 NSW Rail Transport Museum
16 Aust Railway Hist Soc (ACT)
17 Colmore's Pty Ltd Railway
18 Ski-Tube Railway
19 Lachlan Valley Railway Society
20 Tallangatta Rail Presn Society
21 Victorian PTC
22 Illawarra Light Rail Museum
23 Timbertown Railway

Local - Area Industrial Operators

24 BHP
25 AIS
26 Metropolitan Colliery
27 South Bulli Colliery
28 Berrima Cement
29 Medway Cement
30 Manildra Holdings
31 Silverton Tramway Co.
32 Pasminco

Extended - Area Operators

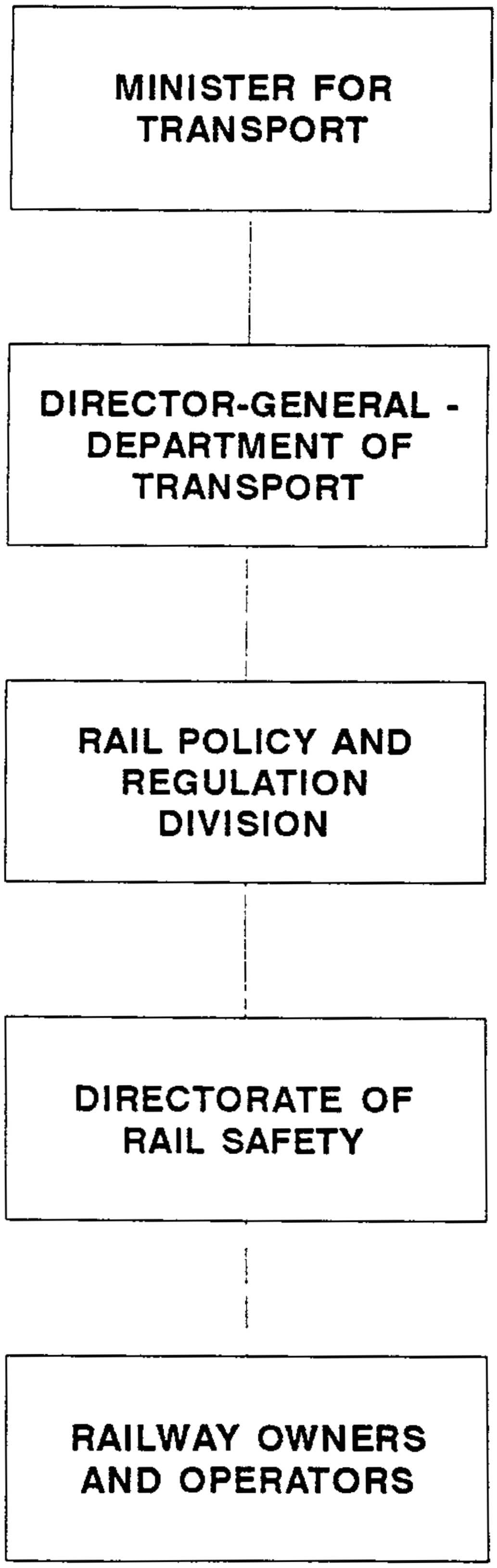
SRA CityRail
SRA Freight Rail
SRA CountryLink
Australian National
National Rail Corporation
3801 Limited
NSW Rail Transport Museum
Australian Railway Hist Soc (ACT)
Rail Motor Society
Australian Trike Assn

NEW SOUTH WALES
DEPARTMENT OF TRANSPORT

RAIL OPERATORS WITHIN NSW

ATTACHMENT 2

RELATIONSHIPS UNDER THE RAIL SAFETY ACT, 1993



International Rail Safety Conference

1993 ANGERS

26 October - 28 October 1993
Hotel Mercure, Angers, France

Paper 9336

Daryl Byrne

Improving Safety Standards in a changing enviroment

Publisher
2000 International Rail Safety Conference

12 October 1993

PUBLIC TRANSPORT CORPORATION OF VICTORIA

EMERGENCY MANAGEMENT AND SAFEWORKING UNIT

INTERNATIONAL SAFETY SEMINAR
ANGERS, FRANCE
OCTOBER 1993

IMPROVING SAFETY STANDARDS IN A CHANGING ENVIRONMENT

EXECUTIVE SUMMARY

Until the 1990's, Australian rail systems went their own separate ways within the Commonwealth and, with minor exceptions, operated within state boundaries. This situation was a reflection of the fragmented nature of European settlement in Australia during the 19th century.

With the growth of the states, the requirements of commerce dictated the need for transcontinental and interstate rail freight and passenger services. This was accommodated within a loose set of working arrangements between the individual State rail systems presided over by an organisation (Railways of Australia) established by the systems themselves to administer these arrangements

Railways of Australia found itself asked to deal with issues where national compatibility and uniformity were compromised because of state interests. This function was performed with inadequate contractual and legislative tools.

Recent years have brought change to the way in which rail services are provided in Australia.

The liberalisation of access to the rail networks has resulted in the franchising of selected sectors of the states' rail network to private organisations.

In 1992, Legislation was enacted in the Commonwealth Parliament and most Australian State Parliaments which created the National Rail Corporation (NRC) with responsibility for providing all interstate rail services in Australia.

As an interim measure, while rationalisation of existing services is being carried out, the responsibility for operations on these routes remains effectively in the hands of the State systems

This is presenting a considerable challenge as regards the ongoing maintenance of safety and safeworking standards under States' legislation set up under the earlier operating regimes.

The organisational structures that have been in place for over 100 years are no longer appropriate to the task. The approach of each of the systems in responding to the problems which these changes are bringing about, is different depending on how these changes are perceived as impacting on the individual States.

The Public Transport Corporation operates public transport services within Victoria. This paper suggests some of the key issues arising out of the changed environment as they are expected to impact on the administration of rail safety in Victoria.

1. THE VICTORIAN RAIL SCENE

Currently, the rail services over which "safeworking" supervision is being exercised by the Public Transport Corporation are as follows:

Interstate Rail Services

- Freight and Passenger Services - Northern corridor (Standard Gauge - 1435 mm.)
- Freight and Passenger Services - Western corridor (Broad Gauge - 1600 mm, to be converted to Standard Gauge.)

Intrastate Rail Services

- Freight & Passenger (Broad Gauge.)
- Freight lines adjacent to interstate trunk lines (to be converted to Standard Gauge.)
- Private lines (interfacing with State system.)
- Private lines operating in isolation (Historical and Tourist Railways.)

2. LEGISLATIVE REQUIREMENTS

Administration of rail safety in Victoria falls within the jurisdiction of, and must comply with the following State Legislation:

Victorian Transport Act 1983.

Occupational Health & Safety Act 1985.

Dangerous Goods Act 1986.

3. THE SAFETY MANAGEMENT PROCESS

THE SYSTEM AS IT PRESENTLY OPERATES

Based on historical precedent, the Public Transport Corporation of Victoria is self-regulating in safety management process. This is also for all other State rail systems operating in Australia.

The setting up of the regulations and standards for safeworking in Victoria and the administration of its application have been under the sole control of the PTC.

Because both operating and safety aspects were handled autonomously and there was a single line of authority for safeworking accreditation. exercise of authority with discipline presented no major organisational difficulties.

This system has, over the years, achieved a high degree of credibility and respect from both the industry and the Public at large. This creditable performance has been achieved with a workforce which has not been subjected to a high level of selectivity, as is applied to the selection of staff in some other industries (e.g. Aviation).

Similarly, cost recovery did not create a problem, as all accreditations and investigations were carried out in-house.

As regards interstate operations. reciprocity of safeworking authorisations was general across State boundaries. Each system bore its own accreditation costs, and formulae existed for the sharing of investigation and restitution costs in the rare event of incidents with serious consequences.

4. AN ERA OF CHANGE AND ADJUSTMENT

With the overlaying of new forms of operation onto the old autonomous system, there are certain interfaces which will continue to exist between the various rail operators.

With the NRC in particular, the provision for transitional arrangements represents a problem in the area of safety. The NRC will, after they have assumed full responsibility for safety, be required to comply to different legislation and standards in each of the States in which it operates.

This raises the question of whether uniformity of safety and safeworking standards throughout Australia should be implemented at this time. This is a separate question outside the scope of this paper, although it has very important implications for the states' rail systems. One implication is that the introduction of this concept could involve a separation of the functions of:

- establishment and maintenance of regulations

- administration of regulations

These and other matters were raised in a report to the national Standing Committee On Transport in September 1993. The Report, in its review of rail safety regulation arrangements, considered the developments taking place throughout the rail industry worldwide and in the road, aviation and marine industries.

Whereas this report suggests alternatives for the regulation and control of rail safety in Australia, it does not discuss, in any detail, the issues that may arise in the existing rail systems in any revised national arrangement for rail safety.

Of major concern to State systems, is how the desired ends are to be achieved without compromising the effective implementation and supervision of rail safety within their jurisdiction.

An examination must be needed at each stage of the transition from state processes to ensure safety is maintained at all times to ensure appropriate solutions to problems are in place.

In relation to these processes, the following are some of the questions which must be considered.

How will the multiplicity of regulatory instruments be consolidated into a working document for all rail users?

What authority/responsibility is the most appropriate to ensure that regulations (be they State or Federal) are complied with?

What organisational structure will best ensure the efficient administration of regulation of diverse rail operators?

How will the costs of regulation and control be recouped?

5. IMPLICATIONS FOR THE PTC

A review of the implications for the PTC (as well as other States' systems) arising out of some of the alternatives canvassed in the SCOT Report, suggests that some functions which the PTC may expect to assume under its ongoing obligations under Victorian Acts of Parliament in the intermediate and longer term, could include:

(1) Regulation and administration of rail safety for intrastate rail services where these continue under the sole ownership and control of the PTC.

(2) During the "initial phase" (first 12 months) of NRC operation safeworking regulation and administration.

(3) During the "transition" phase of the NRC operation (5 years), regulation, compliance, auditing and investigation into incidents.

(4) Accreditation of the NRC staff in safeworking certification and validation.

(5) Regulation and accreditation of private rail operations, with ongoing auditing and monitoring of safeworking operations. This would be administered under the terms of the operating contract with the operator.

6. SAFEWORKING ORGANISATIONAL IMPLICATIONS

The organisation of Safeworking in the PTC has been managed by the Superintendent Safeworking. His functions include policy development, regulation, certification, monitoring, safety audits and incident investigation.

The skills, and the manner in which these have been exercised, will require to be adapted to the new environment which is being introduced as a result of the policy of liberalisation of access to the State rail system in Victoria.

In particular, staff who have been used to the exercise of authority on a line basis, will have to become accustomed to securing results through more indirect methods and frequently across contractual or other interfaces.

Among the issues that need to be considered, so that the PTC may be well placed to meet the safeworking challenges in the evolving railway scene in Australia, the following procedures are currently under review:

- training in safeworking practices and techniques

- certification of operational staff

- accreditation for a range of safeworking activities
- management of incident reporting
- conduct of investigations
- monitoring and auditing of safeworking activities

As part of that review, the procedures for the conduct of investigations into unplanned rail incidents have been substantially rewritten, and is currently being evaluated before formal promulgation. A copy of this document "Incident Investigation Procedure - Public Transport Corporation of Victoria' is attached as an Appendix.

This paper has been prepared as a preliminary step in addressing some of the issues which will become more apparent as we develop expertise in the area of safety management.

We forward the paper to the Conference asking for critical comment and also hope that the Conference can obtain some benefit from what we have started.

It would be of great benefit to the PTC if delegates to the Conference could share their experience in this area of development.

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AUSTRALIA