RAILWAY ENGINEERING

COMPETENCY PROFILES

FIRST EDITION

NATIONAL COMMITTEE ON RAILWAY ENGINEERING

THE INSTITUTION OF ENGINEERS, AUSTRALIA

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1998

ACKNOWLEDGEMENTS

The input of all members of the National Committee on Railway Engineering, of other interested members and administrators of The Institution of Engineers, Australia, of professional academics and of many other interested persons is gratefully acknowledged. This work has been co-ordinated by G C Venn-Brown and J B Scott of the NCRE Sub-committee on Railway Engineering Education.

FOREWORD

This documentation of competencies involved in and required for the professional practice of Railway Engineering has been developed by the National Committee on Railway Engineering (NCRE) of The Institution of Engineers, Australia.

The NCRE considers that the importance of the railway industry to Australia needs wider recognition by the Australian community and that more encouragement and development of the industry would be justified. Of the inputs required to provide for the development of the industry, the technology input is that of principal concern to the NCRE.

This documentation of competencies is intended by the NCRE to assist the understanding of those in railway management and educational circles, in particular, who do not, themselves, specialise in the fields of Railway Engineering. The purpose is to empower those who occupy positions from which they may influence the maintenance and development of the human skills relevant to Railway Engineering so necessary for the long term viability of the railway industry. This recognises the diverse technological basis of the railway industry.

For the practitioners themselves, both present and future, the fields of Railway Engineering are attractive because of their absorbing and rewarding multi-disciplinary nature, because of the challenges they provide and because of the inherent compatibilities of the railway industry with the priorities of today. These priorities include, in particular, social and environmental responsibility.

If this documentation of competencies strengthens the incentives of those who are willing to commit themselves to the betterment of the railway industry in Australia then the efforts of the NCRE to compile it will be amply rewarded.

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1.0 INTRODUCTION

1.1 Development of Document

The development of this documentation of Railway Engineering competencies for professional practitioners has grown from the desire of the National Committee on Railway Engineering (NCRE) of The Institution of Engineers, Australia to explore the diversity of Railway Engineering and to contribute, as far as practicable, to the well-being of the industry.

The current pursuit of these goals, by the encouragement of the development of academic courses of study in Railway Engineering through the documentation of its nature, began by chance discussions between interested engineers whilst attending the Tenth International Wheelset Conference held in Sydney in 1992. The ideas then canvassed were promptly recognised by NCRE as worthy of encouragement and development.

An early step was to carry out a survey within the railway industry to gauge the desire for formalised Railway Engineering Education programs and to understand what form they might take. There was general acceptance of the proposal in principle, although recognition of the potential benefits seemed limited, judging from perceptions as to the availability of funding. Definite interest in the adoption of distance education techniques was shown.

Since 1992 the concept of this document has steadily evolved during NCRE committee discussions and through the background work of the NCRE Sub-committee on Railway Engineering Education. Consideration was given to the funding of the independent development of the desired documentation. As plans progressed, it became clear that as there existed a significant reservoir of expertise in the subject matter within or directly available to the NCRE itself, the most effective approach would be to develop the documentation as an internal NCRE project.

Early in 1996, on behalf of the NCRE, the Sub-committe on Railway Engineering Education circulated a questionaire amongst NCRE members. The stated aims were “to develop a set of guide-lines for, and routes to, Railway Engineering professional competency, which may be used as a basis for standards of Railway Engineering competency” and “to assist professional formation in ..... Railway Engineering”. The responses from the questionaire formed the foundation upon which this document has been built.

It should be made clear that the NCRE considers this to be a “live” document and comment on the content of the document from any interested person willing to contribute would always be welcome.

1.2 Definitions

Towards clarification of the scope of Railway Engineering some definitions of relevance are offered here for the consideration of the reader.

Technology

Technology is knowledge of the objects, techniques and processes which comprise the practical arts. (Source: The Diamond Jubilee symposium papers of The Newcomen Society.)

or

The branch of knowledge that deals with science and engineering, or its practice, as applied to industry; applied science. (Source: Macquarie Dictionary.)

Engineering

The art and science of cost effectively applying technology.

Competency

The ability to perform the activities within an occupation or to function to the standard expected in employment. (Source: Glossary of "National Competency Standards for Professional Engineers", IEAust.)

or

The possession of skills and knowledge and the ability to apply them to standards sufficiently high as to meet community needs and expectations.

Skill

Developed talent.

or

The ability that comes from knowledge, practice, aptitude, etc., to do something well. (Source: Macquarie Dictionary.)

Experience

A process contributing to the formation of competency.

or

Knowledge or practical wisdom gained from what one has observed, encountered or undergone. (Source: Macquarie Dictionary.)

Qualification

Evidence of skill or of competency.

1.3 Railway Engineering Specialisations and Generalism

Railway Engineering is, at once, a specialised endeavour and an occupation affording almost unlimited breadth of engineering opportunity. This is a large part of its attraction to those involved in its practice (and to many on-lookers). Within the realm of Railway Engineering, as in all specialisations, there exist various sub-specialisations. These are the "Spheres of Railway Engineering Activity" tabulated in the Railway Engineering Education Matrix herein.

It must be recognised that the practice of Railway Engineering is not restricted to those who work for railway enterprises. Practitioners find employment in consultancies and within the railway supply industries, and this to an increasing extent. The significance of the work being carried out by these practitioners is increasing as they assume an increasing proportion of the strategic work of Railway Engineering, particularly design and development.

The basis of this document is the thesis that whilst one may commence in the practice of Professional Engineering in a standard specialisation, such as civil, electrical, mechanical engineering, etc., even in a railway enterprise, it is necessary to gain extensive additional knowledge and experience within Railway Engineering practice to approach proficiency as a Railway Engineer. It is to be hoped that the education and experience of professional Railway Engineers can be made so broad that they will have an understanding of the basic issues to be considered in areas of sub-specialisation other than their own or, at least, that the substance of such issues will be quickly assimilable.

At the same time, it is also to be hoped that there will be developed a pool of candidates for senior railway management positions composed of engineers who, amongst their wider accomplishments, are able to adopt a generalist or interdisciplinary approach to their railway vocation, based on competencies achieved in a range of Railway Engineering sub-specialisations.

When considering the development and encouragement of the professional practice of Railway Engineering and the promotion of the railway industry, an appropriate approach would seem to be to identify the various areas of sub-specialisation in order to define what is a specialised, but integrated, multi-disciplinary segment of the engineering profession at large.

There has been no attempt, during the development of this document, to identify core competencies in Railway Engineering. Whilst the relevance of such identification for particular purposes is recognised, it is believed that the purpose of empowerment is better served herein by the broader approach which has been adopted. The AS 4292 series of Railway Safety Management Australian Standards list many factors relevant to the identification of core competencies.

2.0 RAILWAY ENGINEERING EDUCATION

2.1 General

Academic grounding is recognised as an important element of the routes to competency. The achievement of an appropriate academic qualification at the outset, or later in one's career, is an indispensible step towards the achievement of recognition as a professional practitioner.

As is well known, engineering academic studies have usually followed a pattern based on accepted standard specialisations, typically civil, electrical, mechanical, etc.. Amongst courses at the longer established universities this has made engineering courses appear directed or vocational when compared with some of the other more general courses offered. Misconceptions as to the appropriateness of engineering academic grounding for the broader demands of life may have arisen from this. Equally, the true breadth of a good engineering academic grounding may have been underestimated.

In the context of a specialised endeavour such as Railway Engineering Education it needs to be accepted that it matters not so much what the subject matter of education may be as how it is approached and to what depth. The processes of education are, surely, more significant than the subject matter itself. Academic studies having a vocational basis simply add value in that they deal with information and impart knowledge having reasonably direct practical application.

If the foregoing is accepted it would follow that Railway Engineering Education could be as valuable and appropriate at under-graduate level as at post-graduate level. It is acknowledged, however, that the introduction of Railway Engineering Education in Australia is more likely to be initiated at post-graduate level (by distance education) than as an under-graduate course of study. This is so because of the current relatively small size and low density of the Australian railway engineering industry and, no doubt, because there exists a perception that what may be viewed as specialisation at an early stage may lead to narrowed opportunities for subsequent employment.

The Railway Engineering Education Matrix herein has been drawn up with the aim of illustrating both the linkages which exist between the spheres of Railway Engineering activity and the areas of applicability of the various fields of study which might be pursued with benefit by a Railway Engineer. The spheres of Railway Engineering activity are the sub-specialties which are to be identified to define the realm of Railway Engineering and the linkages are what cause it to be an integrated whole, worthy of definition. Whilst the matrix may not be exhaustive, it is offered herein to contribute to an understanding of the constitution of Railway Engineering. Thus, the matrix is pivotal to this document. Put to practical use, the matrix should provide useful guidance for the planning of courses of study in Railway Engineering Education, an important outcome aimed at by those involved in the creation of this document.

It should be recognised that the Railway Engineering Education Matrix herein is limited to some specifics of Railway Engineering. Accordingly, the matrix covers only a portion of the ground to be conquered in the formation of a Professional Engineer. Other publications of The Institution of Engineers, Australia provide broader information for any person wishing to qualify as a Chartered Professional Engineer.

2.2 Background

Australia provides challenges for transportation, including railway transportation, by its combination of great distances and sparse population coupled with relatively great natural and economic wealth. The need for efficiency improvements in transportation within Australia, in the interests of national competitiveness, has been identified by economic studies. A well developed transportation products industry would offer support for efficient transportation and export opportunities important to Australia. Despite all of this there is a dearth of formal study courses in transportation, especially railway transportation.

The Transport Branch of The Institution of Engineers, Australia sponsors a technical program and two British based bodies, at least, The Chartered Institute of Transport and The Institution of Railway Signal Engineers, have active Australian chapters. Also, for engineers wishing to keep in touch with railway matters, in particular, there is the option of subscribing to specialist divisions of the major overseas engineering Institutions and Societies, such as the Rail Transport Division of the American Society of Mechanical Engineers or the Railway Division of The Institution of Mechanical Engineers. For civil engineers there is the option of membership of the American Railway Engineering Association, for example. It should also be noted that there are, particularly in the United States of America, some fine industry based specialist societies in the Railway Engineering realm which have education as a central part of their charter.

Professional links such as those mentioned here are maintained, necessarily, by many Railway Engineers in Australia. With advantage they might well be supplemented by the opportunities for Continuing Professsional Development which locally available courses of study in Railway Engineering could provide.

Australian initiatives to this end, in recent years, have included the operation of the Railway Civil Engineering Course by Queensland Rail, at Cedar Lake, Queensland, and a joint project between City Rail and the University of Wollongong for a training program for senior staff involved in maintenance engineering management. In 1996, the Central Queensland University sponsored an industry meeting, at its Sydney Campus, to discuss a Graduate Diploma in Railway Engineering.

Overseas there have been numerous instances of academic institutions pursuing railway studies and providing Railway Engineering study courses over many years. In the 1920s there was a Chair of Transportation at the Harvard Business School. Before that Purdue University had a locomotive testing plant. Later, the University of Illinois carried out and reported on important railway related investigation work at its Engineering Experiment Station. The People's Republic of China has a University dedicated to railway studies. Sheffield University has established the Advanced Rail Research Centre which offers a post-graduate course.

There must be many examples of specialist courses in Railway Engineering in addition to those quoted above. The main points to be recognised are that the idea of conducting such courses is well established and that the practice continues.

2.3 Railway Engineering Education Matrix

The purpose of the Railway Engineering Education Matrix, which follows, is explained at 2.1. To construct the matrix, the sub-specialties of Railway Engineering have been grouped into nine spheres. The nine spheres and a listing of fields of study applicable to Railway Engineering have been arranged in matrix form to enable the illustration of linkages between the spheres and the fields of study.

At the conjunctions of the matrix are shown references to the schedules of 2.4. These schedules are listings of Railway Engineering specific subject matter relevant to each of the listed fields of study.

The linkages are to be interpreted from the heavy shading, light shading or the absence of shading, at matrix conjunctions, according to the key which follows the matrix. Heavy shading at a conjunction between any sphere and a particular field of study indicates that the particular field of study is central to the sphere and that a detailed knowledge of the field of study is required, sufficient to enable its subject matter to be put into practice in detail. Light shading indicates that, in the foregoing terms, a general knowledge of practice is sufficient. An absence of shading at a conjunction indicates that a Railway Engineer, active in any sphere, requires no more than a basic knowledge of the principles specific to the field of study.

The lightly shaded conjunctions identify significant linkages which may not be obvious at first sight and which do require more than a basic knowledge. The clear illustration of these particular linkages is central to the adoption of the matrix.

The first field of study tabulated in the Railway Engineering Education Matrix, “Introduction to Railway Engineering”, is just as its title suggests, a preliminary and broad coverage of what is essential to Railway Engineering. There is no schedule of subject matter specific to this field of study as its subject matter is that of all of the other listed fields of study. A syllabus for a course of study in this field would be constructed following consideration of all of the spheres of Railway Engineering.

Railway Engineering Education Matrix

FIELDS OF STUDY	SPHERES OF RAILWAY ENGINEERING ACTIVITY								
	Business Liaison and Management	**Power Supply for Electric Traction**	**Railway Planning and Economics**	**Rolling Stock**	**Signalling and Communicat-ions**	**Terminals**	**Track and Structures**	**Train Control and Operations**	**Workshops**
Introduction to Railway Enginering									
Railway customer liaison	Schedule 1.1	Schedule 1.1	Schedule 1.1	Schedule 1.1	Schedule 1.1	Schedule 1.1	Schedule 1.1	Schedule 1.1	Schedule 1.1
Railway traffic planning	Schedule 1.2	Schedule 1.2	Schedule 1.2	Schedule 1.2	Schedule 1.2	Schedule 1.2	Schedule 1.2	Schedule 1.2	Schedule 1.2
Railway general management	Schedule 1.3	Schedule 1.3	Schedule 1.3	Schedule 1.3	Schedule 1.3	Schedule 1.3	Schedule 1.3	Schedule 1.3	Schedule 1.3
Railway power supply design and specification	Schedule 2.1	Schedule 2.1	Schedule 2.1	Schedule 2.1	Schedule 2.1	Schedule 2.1	Schedule 2.1	Schedule 2.1	Schedule 2.1
Railway power supply manufacture and installation	Schedule 2.2	Schedule 2.2	Schedule 2.2	Schedule 2.2	Schedule 2.2	Schedule 2.2	Schedule 2.2	Schedule 2.2	Schedule 2.2
Railway power supply operation	Schedule 2.3	Schedule 2.3	Schedule 2.3	Schedule 2.3	Schedule 2.3	Schedule 2.3	Schedule 2.3	Schedule 2.3	Schedule 2.3
Railway power supply maintenance	Schedule 2.4	Schedule 2.4	Schedule 2.4	Schedule 2.4	Schedule 2.4	Schedule 2.4	Schedule 2.4	Schedule 2.4	Schedule 2.4

Railway Engineering Education Matrix (cont.)

FIELDS OF STUDY	SPHERES OF RAILWAY ENGINEERING ACTIVITY								
	Business Liaison and Management	**Power Supply for Electric Traction**	**Railway Planning and Economics**	**Rolling Stock**	**Signalling and Communicat-ions**	**Terminals**	**Track and Structures**	**Train Control and Operations**	**Workshops**
Transportat-ion economics	Schedule 3.1	Schedule 3.1	Schedule 3.1	Schedule 3.1	Schedule 3.1	Schedule 3.1	Schedule 3.1	Schedule 3.1	Schedule 3.1
Railway planning	Schedule 3.2	Schedule 3.2	Schedule 3.2	Schedule 3.2	Schedule 3.2	Schedule 3.2	Schedule 3.2	Schedule 3.2	Schedule 3.2
Rolling stock design and specification	Schedule 4.1	Schedule 4.1	Schedule 4.1	Schedule 4.1	Schedule 4.1	Schedule 4.1	Schedule 4.1	Schedule 4.1	Schedule 4.1
Rolling stock manufacture	Schedule 4.2	Schedule 4.2	Schedule 4.2	Schedule 4.2	Schedule 4.2	Schedule 4.2	Schedule 4.2	Schedule 4.2	Schedule 4.2
Rolling stock operation	Schedule 4.3	Schedule 4.3	Schedule 4.3	Schedule 4.3	Schedule 4.3	Schedule 4.3	Schedule 4.3	Schedule 4.3	Schedule 4.3
Rolling stock maintenance	Schedule 4.4	Schedule 4.4	Schedule 4.4	Schedule 4.4	Schedule 4.4	Schedule 4.4	Schedule 4.4	Schedule 4.4	Schedule 4.4

Railway Engineering Education Matrix (cont.)

FIELDS OF STUDY	SPHERES OF RAILWAY ENGINEERING ACTIVITY								
	Business Liaison and Management	**Power Supply for Electric Traction**	**Railway Planning and Economics**	**Rolling Stock**	**Signalling and Communicat-ions**	**Terminals**	**Track and Structures**	**Train Control and Operations**	**Workshops**
Signals design and specification	Schedule 5.1	Schedule 5.1	Schedule 5.1	Schedule 5.1	Schedule 5.1	Schedule 5.1	Schedule 5.1	Schedule 5.1	Schedule 5.1
Signals manufacture and installation	Schedule 5.2	Schedule 5.2	Schedule 5.2	Schedule 5.2	Schedule 5.2	Schedule 5.2	Schedule 5.2	Schedule 5.2	Schedule 5.2
Signals operation	Schedule 5.3	Schedule 5.3	Schedule 5.3	Schedule 5.3	Schedule 5.3	Schedule 5.3	Schedule 5.3	Schedule 5.3	Schedule 5.3
Signals maintenance	Schedule 5.4	Schedule 5.4	Schedule 5.4	Schedule 5.4	Schedule 5.4	Schedule 5.4	Schedule 5.4	Schedule 5.4	Schedule 5.4
Railway communicat-ions systems design and specification	Schedule 5.5	Schedule 5.5	Schedule 5.5	Schedule 5.5	Schedule 5.5	Schedule 5.5	Schedule 5.5	Schedule 5.5	Schedule 5.5
Railway communicat-ions systems manufacture and installation	Schedule 5.6	Schedule 5.6	Schedule 5.6	Schedule 5.6	Schedule 5.6	Schedule 5.6	Schedule 5.6	Schedule 5.6	Schedule 5.6

Railway Engineering Education Matrix (cont.)

FIELDS OF STUDY	SPHERES OF RAILWAY ENGINEERING ACTIVITY								
	Business Liaison and Management	**Power Supply for Electric Traction**	**Railway Planning and Economics**	**Rolling Stock**	**Signalling and Communicat-ions**	**Terminals**	**Track and Structures**	**Train Control and Operations**	**Workshops**
Railway communicat-ions systems operation	Schedule 5.7	Schedule 5.7	Schedule 5.7	Schedule 5.7	Schedule 5.7	Schedule 5.7	Schedule 5.7	Schedule 5.7	Schedule 5.7
Railway communicat-ions systems maintenance	Schedule 5.8	Schedule 5.8	Schedule 5.8	Schedule 5.8	Schedule 5.8	Schedule 5.8	Schedule 5.8	Schedule 5.8	Schedule 5.8
Railway freight terminal design and specification	Schedule 6.1	Schedule 6.1	Schedule 6.1	Schedule 6.1	Schedule 6.1	Schedule 6.1	Schedule 6.1	Schedule 6.1	Schedule 6.1
Railway freight terminal operation	Schedule 6.2	Schedule 6.2	Schedule 6.2	Schedule 6.2	Schedule 6.2	Schedule 6.2	Schedule 6.2	Schedule 6.2	Schedule 6.2
Railway passenger terminal design and specification	Schedule 6.3	Schedule 6.3	Schedule 6.3	Schedule 6.3	Schedule 6.3	Schedule 6.3	Schedule 6.3	Schedule 6.3	Schedule 6.3
Railway passenger terminal operation	Schedule 6.4	Schedule 6.4	Schedule 6.4	Schedule 6.4	Schedule 6.4	Schedule 6.4	Schedule 6.4	Schedule 6.4	Schedule 6.4

Railway Engineering Education Matrix (cont.)

FIELDS OF STUDY	SPHERES OF RAILWAY ENGINEERING ACTIVITY								
	Business Liaison and Management	**Power Supply for Electric Traction**	**Railway Planning and Economics**	**Rolling Stock**	**Signalling and Communicat-ions**	**Terminals**	**Track and Structures**	**Train Control and Operations**	**Workshops**
Track design and specification	Schedule 7.1	Schedule 7.1	Schedule 7.1	Schedule 7.1	Schedule 7.1	Schedule 7.1	Schedule 7.1	Schedule 7.1	Schedule 7.1
Track manufacture and construction	Schedule 7.2	Schedule 7.2	Schedule 7.2	Schedule 7.2	Schedule 7.2	Schedule 7.2	Schedule 7.2	Schedule 7.2	Schedule 7.2
Track maintenance	Schedule 7.3	Schedule 7.3	Schedule 7.3	Schedule 7.3	Schedule 7.3	Schedule 7.3	Schedule 7.3	Schedule 7.3	Schedule 7.3
Pointwork design and specification	Schedule 7.4	Schedule 7.4	Schedule 7.4	Schedule 7.4	Schedule 7.4	Schedule 7.4	Schedule 7.4	Schedule 7.4	Schedule 7.4
Pointwork manufacture and construction	Schedule 7.5	Schedule 7.5	Schedule 7.5	Schedule 7.5	Schedule 7.5	Schedule 7.5	Schedule 7.5	Schedule 7.5	Schedule 7.5
Pointwork maintenance	Schedule 7.6	Schedule 7.6	Schedule 7.6	Schedule 7.6	Schedule 7.6	Schedule 7.6	Schedule 7.6	Schedule 7.6	Schedule 7.6
Railway structures design and specification	Schedule 7.7	Schedule 7.7	Schedule 7.7	Schedule 7.7	Schedule 7.7	Schedule 7.7	Schedule 7.7	Schedule 7.7	Schedule 7.7
Railway structures maintenance	Schedule 7.8	Schedule 7.8	Schedule 7.8	Schedule 7.8	Schedule 7.8	Schedule 7.8	Schedule 7.8	Schedule 7.8	Schedule 7.8

Railway Engineering Education Matrix (cont.)

FIELDS OF STUDY	SPHERES OF RAILWAY ENGINEERING ACTIVITY								
	Business Liaison and Management	**Power Supply for Electric Traction**	**Railway Planning and Economics**	**Rolling Stock**	**Signalling and Communicat-ions**	**Terminals**	**Track and Structures**	**Train Control and Operations**	**Workshops**
Train control systems	Schedule 8.1	Schedule 8.1	Schedule 8.1	Schedule 8.1	Schedule 8.1	Schedule 8.1	Schedule 8.1	Schedule 8.1	Schedule 8.1
Train systems	Schedule 8.2	Schedule 8.2	Schedule 8.2	Schedule 8.2	Schedule 8.2	Schedule 8.2	Schedule 8.2	Schedule 8.2	Schedule 8.2
Train handling	Schedule 8.3	Schedule 8.3	Schedule 8.3	Schedule 8.3	Schedule 8.3	Schedule 8.3	Schedule 8.3	Schedule 8.3	Schedule 8.3
Railway workshop design and specification	Schedule 9.1	Schedule 9.1	Schedule 9.1	Schedule 9.1	Schedule 9.1	Schedule 9.1	Schedule 9.1	Schedule 9.1	Schedule 9.1
Railway workshop operations	Schedule 9.2	Schedule 9.2	Schedule 9.2	Schedule 9.2	Schedule 9.2	Schedule 9.2	Schedule 9.2	Schedule 9.2	Schedule 9.2
Railway workshop plant maintenance	Schedule 9.3	Schedule 9.3	Schedule 9.3	Schedule 9.3	Schedule 9.3	Schedule 9.3	Schedule 9.3	Schedule 9.3	Schedule 9.3

KEY:

Basic knowledge of principles required	**General knowledge of practice required**	**Detailed knowledge of practice required**	**Introduction to Railway Engineering**

2.4 Railway Engineering Education Subject Matter Schedules

The schedules which follow, one for each of the fields of study listed in the preceding Railway Engineering Education Matrix (at 2.3), are not syllabi. A schedule is a listing, not necessarily exhaustive, for use as a guide to subject matter to be included in a thorough study of the relevant field. The items listed in the schedules are arranged alphabetically, not in any order of priority.

A syllabus for a course of study would be prepared from an extensive knowledge of the field. The relevant and associated schedules of 2.4 could aid the framing of a particular syllabus by documenting acceptable demarcations of subject matter.

Many of the listings in the schedules are railway specific and this is clear from the wording. Where more general wording has been adopted for a listing, it should be assumed that the subject matter should be approached within the railway context for purposes of Railway Engineering Education. This does not preclude the development of broad syllabi designed to place elements of Railway Engineering in perspective.

2.4.1 BUSINESS LIAISON AND MANAGEMENT

Business Liaison and Management is the area of professional Railway Engineering practice which lies at the interface between railway freight or passenger marketing and operational management (typically a non-engineering activity) and the management of the (engineering) resources which provide and develop the technological basis necessary to a railway enterprise.

This sphere of activity facilitates the focussing of the technological resources of a railway enterprise upon customer needs and expectations and the adaptation of the rolling stock and infrastructure of a railway to changing demands of traffic. It incorporates activities which can be taken to form part of the processes of railway general management.

Schedule 1.1 Railway customer liaison

Railway freight business liaison
Railway operations and processes
Railway passenger business liaison
Railway vehicle maintenance and construction

Schedule 1.2 Railway traffic planning

Emergency planning
Fuel conservation
Railway operating methods and operations control
Train communications systems
Train operations modelling
Train scheduling techniques
Vehicle information and tracking systems

Schedule 1.3 Railway general management

Accreditation procedures
Capital investment strategies
Codes and standards
Environment protection
Equipment procurement and support policies
Financial modelling
Incident management
Management of information sytems
Marketing
Organising for quality
Personnel practices and career planning
Public relations
Railway accounts
Railway comparative statistics and performance indicators
Railway financing
Railway legal issues
Railway organisational structures and system coordination
Railway safety accreditation
Risk management for railways
Rolling stock interchange agreements
Safety and training at work

2.4.2 POWER SUPPLY FOR ELECTRIC TRACTION
(OFF-TRAIN SOURCES)

Power supply for electric traction encompasses the whole range of engineering options which may be involved in the provision of railway traction electric power from off-train sources.

Schedule 2.1 Railway power supply design and specification

AC and DC electric power distribution systems
Current collection systems - overhead and track based
Protection
Switchgear
Traction current return systems
Train regenerative brake systems
Transformers and convertors

Schedule 2.2 Railway power supply manufacture and installation

Railway power supply manufacture and installation

Schedule 2.3 Railway power supply operation

Current collection systems in operation
Power supply supervisory systems
Regenerative braking
Train interaction

Schedule 2.4 Railway power supply maintenance

Safeworking practices for power supply maintenance

2.4.3 RAILWAY PLANNING AND ECONOMICS

Railway planning and economics provides the technology focus required for the development of rational transportation policy and initiatives.

Schedule 3.1 Transportation economics

Costs of transportation system establishment, operation and maintenance
Forms of railway transportation
History of transportation systems
Political and microeconomic implications of transportation
Social and environmental accounting in relation to transport systems
Transportation planning for the community

Schedule 3.2 Railway planning

Agricultural and sugar cane railway planning
Freight terminal operations
Freight terminal systems
Freight train systems and strategies
Freight wagon systems
Intermodal systems
Light rail systems
Passenger train types and their applications
Passenger terminal planning
Railway operating methods and operations control
Track gauge

2.4.4 ROLLING STOCK

Rolling stock engineering encompasses a multi-disciplinary sphere of technical engineering practice. It is a sphere of professional Railway Engineering activity which, after nearly two centuries of existence, continues to involve the rapid development and application of a wide range of specialised technologies.

Schedule 4.1 Rolling stock design and specification

AC and DC traction systems
Air brake systems
Air-conditioning systems
Applied loadings on rail vehicles
Brake gear design
Diesel traction power plants
Door systems
Draft gear and coupler systems
Dynamic and regenerative braking systems
Dynamic response attenuation and wear reduction strategies
Electric multiple unit vehicle design
Electric power transmission systems
Electropneumatic braking systems
Freight containers
Freight wagon design
High speed train design
Hopper design
Light rail vehicles
Loading and discharge systems
Locomotive and train auxiliary systems
Locomotive configurations
Locomotive design
Noise and vibration analysis and attenuation
Non-electric power transmission systems
On-board condition monitoring systems
Pantograph design
Passenger compartment design
Passenger vehicle communications systems
Passenger vehicle design
Payload characteristics
Pressure sealing systems
Rack locomotive systems
Rail vehicle structural design
Rail vehicles and running gear structural testing
Remote control driving systems
Rolling stock and bridge interaction
Running gear and vehicle dynamic response
Running gear and bogie design
Running gear dynamics
Safety issues
Suspension system design
Track and train dynamics
Traction control systems
Vehicle stability
Vehicle testing
Wheel and rail studies

Wheel bearing systems
Wheelset design
Work station design and ergonomics

Schedule 4.2 Rolling stock manufacture

Rolling stock manufacture

Schedule 4.3 Rolling stock operation

Rolling stock incident investigation
Vehicle performance monitoring

Schedule 4.4 Rolling stock maintenance

Costing and performance indicators for rolling stock maintenance
Facilities and equipment for rolling stock maintenance
Planning and recording for rolling stock maintenance
Vehicle condition monitoring
Vehicle configuration control

2.4.5 SIGNALLING AND COMMUNICATIONS

Signalling and communications encompasses all engineering input required to provide signalling and communications for a railway system.

Schedule 5.1 Signals design and specification

Advanced train control
Automatic warning systems
Electromagnetic interference
Geographical circuitry and land crossings
Interlocking and control equipment principles
Railway signalling principles
Remote control systems
Signal and track circuit layouts
Signalling equipment design
Train description and detection systems

Schedule 5.2 Signals manufacture and installation

Signals manufacture and installation

Schedule 5.3 Signals operation

Signal location and sighting
Signalling supervisory systems

Schedule 5.4 Signals maintenance

Safeworking for signals maintenance

Schedule 5.5 Railway communications systems design and specification

Railway communications systems design and specification

Schedule 5.6 Railway communications systems manufacture and installation

Railway communications systems manufacture and installation

Schedule 5.7 Railway communications systems operation

Railway communications systems operation

Schedule 5.8 Railway communications systems maintenance

Railway communications systems maintenance

2.4.6 TERMINALS

Terminals encompasses the engineering aspects of railway terminals of all kinds.

Schedule 6.1 Railway freight terminal design and specification

Freight terminal automated systems
Freight terminal layout and design
Freight terminal planning and economics
Intermodal systems
Layout and design of freight terminals
Materials handling systems

Schedule 6.2 Railway freight terminal operation

Dangerous goods handling
Freight handling
Freight terminal operations
Load securement

Schedule 6.3 Railway passenger terminal design and specification

Passenger terminal design for interchange
Passenger terminal layout and design
Passenger terminal planning and economics
Ticketing systems for passengers

Schedule 6.4 Railway passenger terminal operation

Passenger handling
Passenger terminal operations

2.4.7 TRACK AND STRUCTURES

Track and structures encompasses the engineering aspects of the whole range of trackwork and railway lineside structures required for a railway system.

Schedule 7.1 Track design and specification

Cumulative track damage
Life-cycle costs of track
Rail metallurgy
Route location and alignment
Sleeper, ballast and sub-grade system design
Structural design of rail
Testing standards and techniques
Track and train dynamics
Track design for electric traction
Track incident investigation
Track irregularities
Track stability
Track system design and specification
Wheelset and track interaction

Schedule 7.2 Track manufacture and construction

Ballast manufacture and testing
Rail manufacture
Rail welding
Sleeper production

Schedule 7.3 Track maintenance

Rail defects
Rail lubrication systems
Rail running surface maintenence
Rail stress and track stability management
Safeworking for track maintenance
Track inspections and records
Track machines
Track maintenance
Track maintenance planning and coordination
Track upgrading
Vegetation control

Schedule 7.4 Pointwork design and specification

Pointwork design
Pointwork operating system design

Schedule 7.5 Pointwork manufacture and construction

Pointwork assembly
Steel foundry technology

Schedule 7.6 Pointwork maintenance

Pointwork maintenance
Pointwork maintenance planning and coordination
Safeworking for pointwork maintenance

Schedule 7.7 Railway structures design and specification

Drainage and flood protection for railways
Railway bridge and structure rating
Railway bridge and structure types
Railway bridge structural design
Railway overhead equipment structural design
Structure clearance outlines
Tunnel design for railways

Schedule 7.8 Railway structures maintenance

Railway bridge and structure inspection
Railway bridge and structure maintenance
Railway bridge and structure maintenance planning and coordination
Safeworking for railway structures maintenance

2.4.8 TRAIN CONTROL AND OPERATIONS

Train control and operations encompasses the technical basis of train operations on a railway system.

Schedule 8.1 Train control systems

Automated and on-board signalling and control
Centralised traffic control
Safeworking for train operations
Signalling systems
Tracking technology for vehicles and trains
Train description and detection systems

Schedule 8.2 Train systems

Agricultural and sugar cane railway train systems
Freight train systems and strategies
Light rail systems
Passenger train systems
Train braking systems

Schedule 8.3 Train handling

In-train dynamics
Remote control driving systems
Train brake manipulation and control

2.4.9 WORKSHOPS

Workshops encompasses the engineering and management aspects of a railway workshop which are peculiar to that form of workshop.

Schedule 9.1 Railway workshop design and specification

Electric traction requirements
Roll-over jigs
Turntables and traversers
Wheel shop equipment
Workshop planning and layout
Workshop trackwork design

Schedule 9.2 Railway workshop operations

Control of contract maintenance
Production control
Safeworking for workshop operations
Special techniques for the manufacture and maintenance of rolling stock
Vehicle cleaning and preparation
Workload balancing
Workshop management

Schedule 9.3 Railway workshop plant maintenance

Railway workshop plant maintenance

3.0 STANDARDS AND ROUTES TO COMPETENCY

The professional standards of competency and practice required in the realm of Railway Engineering should not deviate from those laid down for corporate membership or Chartered status by the major engineering Institutions, including The Institution of Engineers, Australia.

In conformance with the guidelines for professional formation laid down by the Institutions, bases for the attainment of competency include:

- academic grounding;
- involvement in relevant and creative original work (especially design involvement);
- the achievement of responsibility for
    - strategy
    - the efficient management of resources;
- demonstrable accountability for key outcomes;
- the achievement of a breadth of understanding of an interdisciplinary nature across a range of areas of specialisation;
- involvement in Continuing Professional Development.

Broad categorisations, such as those above, need not be and should not be restrictive. Criteria for judging the standing of any individual in such categories of achievement should not be allowed to become unduly prescriptive. There is always room for individuality in respect of knowledge and experience and the patterns of two individuals will never precisely match. Considerations will include the length and variety of experience gained and the levels achieved.

Rather than an approach involving ranking and the possible exclusion of some practitioners, it should be the aim to begin by setting a minimum acceptable standard and then to institute programs to aid Continuing Professional Development, these widely accessible and having a theme of encouragement rather than duress. The overall purpose would be to assist as many practitioners as possible to demonstrate compliance with the standard.

The routes to competency may vary considerably from individual to individual, depending upon circumstances and opportunities. The particular sphere of Railway Engineering activity being aimed at (initially) would also influence the approach.

For some years, now, a re-ordering of the railway industry in Australia has been altering the availability of opportunities for professional formation in Railway Engineering to a considerable extent. Historically, in Australia in particular, railway employment has been a working lifetime single employer careeer. The railways operated comprehensive apprenticeship and training schemes and usually sponsored the more able participants in further education. Any employee with initiative and ability and reasonably good fortune could gain a good grounding and excellent professional development within a single railway. The modern lack of such circumstances (in the main) is an aspect being addressed herein. Modern circumstances appear to dictate that gaining experience with a variety of employers within the railway industry will be a most desirable route to competency.

Obviously, participation in high quality academic courses of study in Railway Engineering would form an excellent part of a most appropriate route to competency as a Railway Engineer. The potential benefit to the railway industry is enormous. This has been the theme of this document.

4.0 CONCLUSION

Having gathered together the data presented in this document, it is hoped that the result will be found to be useful for reference in the formulation of plans for the betterment of the practice of Railway Engineering at a professional level and, thus, the railway industry served. Railway Engineering Education should be an important focus of such planning.

It is believed that this document contributes to the development of an enhanced definition of Railway Engineering as a professional pursuit, especially in Australia. This is seen as necessary and appropriate. Just as it is a function of The Institution of Engineers, Australia to define Professional Engineering, so must it be it a function of the National Committee on Railway Engineering, of The Institution, to define Railway Engineering within the professional context.

Whilst this document has been designed to stand alone, it should be recognised as a building block for the implementation of wider strategies of the NCRE, and of other concerned parties, in support of Railway Engineering.

Finally, it is emphasised that constructive input to assist the enhancement of this document will be welcomed by the NCRE at any time.

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