Chapter Abstracts

Introduction:

The authors of the "Practical Guide To Railway Engineering" wish to provide the reader a general overview of the specific disciplines common to railway engineering. Railway engineering design requires that the engineer approach any modern engineering challenge with an understanding that encompasses the railway as a system; thereby requiring the practicing engineer have a general understanding of disciplines other than just their own. The text hereafter is not intended to supplant the AREMA Manual for Railway Engineering, the AREMA C&S Manual or other comprehensive texts covering specific railway engineering disciplines, but rather to provide background enabling the novice engineer or practicing engineer unfamiliar with railway engineering design to utilize available resources. Each author and contributor shares a deep love for the industry, and it is their desire that the pool of collected information be passed on to the next generation of "railroader" as well.

Chapter 1 – Railway Development

Chapter 1 provides a brief overview of the key occurrences in the history of transportation leading up to the introduction and implementation of railways and railway engineering in North America. The goal of this chapter is for the reader to obtain an appreciation for the reasons behind some of the key current railway engineering practices based on railway development history. The significant economic role played by innovations such as CWR, CTC, mechanization of maintenance activities, along with the evolution of bridge design, materials and construction practices is explored.

Chapter 2 – Railway Industry Overview

Chapter 2 is designed so the reader will gain an understand of the organizational structure of a railway and to recognize the role played in railway operations by safety, operating rules, authority of movements, speeds and traffic control systems. Critical issues affecting railway traffic systems are also considered. Various car configurations and related usage are identified along with factors governing locomotive utilization including:

- horsepower and tractive effort
- tractive force and adhesion
- drawbar pull
- train resistance
- compensated grades
- acceleration and balance speeds
- tonnage ratings
- ruling grade
- momentum grade
- power to stop

Chapter 3 – Basic Track

Chapter 3 is written for the reader to become more familiar with track components and terminology and includes over 100 illustrations. The reader will understand the criteria used to justify maintenance operations and/or capital improvement as well as recognize

the role of track geometry in maintaining and operating today's railway. Specific maintenance activities along with the function of major production gang activities are discussed. The role of safety and safety enforcement is also addressed here.

Chapter 4 – Right-of-Way and Roadway

Chapter 4 seeks to explain how right of way is defined and utilized. This chapter includes typical dimensions, property rights, limitations, utility easements, fencing, and vegetation. Also addressed are issues concerning; basic soil types, geotechnical behavior of various types of soils, typical track structure and the loading it imposes on the subgrade, roadbed failure (landslides and track settlement) causes and remediation, and ways to identify potential hazards to the roadbed and take appropriate action to mitigate those hazards.

Chapter 5 – Drainage

Chapter 5 stresses the importance of drainage in maintaining quality track. The primary hydrology and hydraulic principles are reviewed along with a demonstration of the use of commonly available resources. Consideration is provided to the impact poor drainage design can have on railway neighbors as well as the integrity of the railway itself.

Chapter 6 – Railway Track Design

Chapter 6 provides information pertaining to the different design elements of railway alignments, layout and design. Specific topics include horizontal and vertical alignment design, turnout geometry, location, and use; railway clearances and vehicular envelope requirements; typical yard and terminal functions and layouts. Additional considerations pertaining specifically to design elements of railway alignments and limitations are discussed as they relate to proposed use (i.e. mainline, branch line, industrial/terminal, and passenger).

Chapter 7 – Communications and Signals

Chapter 7 is intended as a basic overview of railway signaling. The chapter provides an appreciation of the historical development of railway signal systems as well as an understanding of basic signal terminology. An easy to understand approach explains concepts such as ABS and CTC. Basic types of signals, available energy sources, lightning and surge protection and basic track circuits including: DC track circuits, Coded DC track circuits, Style C track circuits, Overlay track circuits and AC track circuits are addressed here. An understanding of track switches, components and their interconnection to the signal system is provided. Crossing warning device theory of operation and differences between conventional and solid state devices is highlighted. The basic principles of CTC, sequence of operation and safety checks are explained along with concepts associated with microprocessor based coded track circuits and solid-state interlockings. Finally, a description of the common types of defect detectors in use is provided.

Chapter 8 – Railway Structures

Chapter 8 was prepared to accomplish two primary objectives. For the novice engineer, the authors wished to provide an overview of the types of railway bridge structures and their appropriate usage as well as define the primary bridge components and their functions. Further, drainage structures, retaining walls, tunnels and sheds are classified by type as well as by common use. For the experienced highway design engineer, the common design approach differences between highway and railway bridges are reviewed. Discussion centers on the differences in design loading in Timber Chapter 7, Concrete Chapter 8 and Steel Chapter 15 of the AREMA Manual for Railway Engineering. Other critical structure criteria are highlighted such as fatigue, fracture critical members, structure serviceability, bearings and volumetric changes and composite design.

Chapter 9 – Railway Electrification

Chapter 9 compares the various alternatives available when considering and designing an electrified railway. A general overview of the key components and their primary function is provided for 3rd rail systems and overhead catenary systems (OCS). Fundamental criteria for selection of style of OCS are discussed along with other design basics. Finally, the impact that implementation of electrification will have on existing railroad infrastructure, staff and community is discussed.

Chapter 10 – Passenger, Transit and High-Speed Rail

Chapter10 presents an overview of typical design principles, construction practices and maintenance considerations applied to passenger rail lines. It describes how basic railroad engineering principles are applied in specialized ways to accommodate passenger rail requirements. The chapter notes the key distinctions between railroad and transit operations and introduces six major types of passenger rail modes. The text then discusses the service, infrastructure, regulatory (U.S.), maintenance and inspection considerations associated with each. It concludes with discussion of the special topics of line capacity and cant deficiency.

Chapter 11 - Environmental Regulations And Permitting

Chapter 11 is a general overview of environmental regulations and permitting in the U.S., Canada and Mexico with topics that may be encountered during railway activities (including construction, as well as operation). This information is general in nature and the reader is cautioned to contact or use a professional environmental consultant to prepare an Environmental Assessment. Information is given on wetland issues along with other topics, such as endangered species, cultural resources, Phase I environmental assessments, hazardous waste, brownfields, asbestos and air quality. Environmental information includes: the U.S. Army Corps of Engineers wetland definition, Nationwide and General permits for proposed construction activities, U.S. Army Corps of Engineers non-jurisdictional status over isolated wetlands and Best Management Practices (which

mitigate direct and indirect degradation of the environment to the extent possible). Each topic concludes on where to locate additional information.

Chapter 12 – European Curve & Turnout Mechanics

Chapter 12 serves to provide an appreciation of the European approach design differences in turnout and curve design from that experienced in North America. The reader will obtain an understanding of the geometrical and mathematical relationships common to both North American and European track geometry. The potential for incorporating European practices in high-speed North American transit initiatives is clearly obvious.

Chapter 13 – Case Studies

Chapter 13 presents four case studies drawn from actual railway design projects using formatted templates to identify critical stakeholders, identify controlling criteria, recognize potential problems, and learn from past mistakes. These case studies are intended to serve as a model for which the templates can be utilized for any railway design/construction project. It is intended that this will be part of an accessible library of case study solutions yet to be developed.

Appendix

The Appendix contains a wide variety of useful and related information to the material presented in the text. Included are articles describing the development of maintenance-of-way practices in the past 40 years from the perspective of a retired Class 1 chief engineer, geometry solutions for turnout and connection track location, spiral and full body curve example problem solutions, Bartlett Method of calculating throws for stringlining curves and a synopsis of one Class 1 railway's step by step procedures for performing common maintenance and capital improvement activities.

Glossary

The glossary contains short definitions of the majority of the terms utilized within the text. Railway engineering terminology common to the industry is often not self-explanatory. It is essential that the engineer have a clear understanding of the terms in use.