

## Introduction

**Project Goal:** *To facilitate the successful introduction of modern streetcar vehicles into North American systems by promoting understanding of the core technical and operational issues.*

Presently, there is no comprehensive source for recommended practice guidance for modern streetcar vehicles in North America. With the rapidly increasing demand for modern streetcar systems, and the limited familiarity with the vehicles by North American agencies and manufacturers, a coordinated effort is needed to help ensure that this industry segment reaches its full potential. It is important to help control vehicle costs by avoiding a situation where suppliers are providing entirely separate products for the North American market, or a situation where domestically produced vehicles are not competitive in other markets.

Modern light rail and streetcar vehicles are fundamentally very similar, the differences having largely to do with how they are applied. The primary difference between the two modes is the degree of integration into the urban environment. This difference in application makes some common LRV design features unnecessary for streetcar application, but may also require the use of other design elements that may or may not be incorporated into a typical light rail vehicle.

Just as the APTA Light Rail Procurement Specification (2010) is designed to help control costs for Light Rail Vehicle procurement, the Subcommittee's white paper / guideline document will seek to help control costs for modern streetcar vehicles. It is estimated that North American agencies will spend over \$2 billion dollars for the purchase of modern streetcar vehicles over the next ten years. If this industry segment can do an effective job of internal education and related standards work, vehicles and systems will better match, and cost savings will follow.

The document will seek to promote understanding of the core technical and operational issues relating to modern streetcar vehicles and systems. From this understanding, agencies will be able to better navigate the process of specifying a vehicle and designing compatible infrastructure. Similarly, suppliers will be provided with a better understanding of the differences between North American and world operating and regulatory environments. This will facilitate the adaptation of existing modern streetcar designs for the North American market and help make domestically produced vehicles a competitive, world-class product for all markets.

The document will also serve as a scoping document to review where additional standards, or modifications of existing standards, may be needed to facilitate the successful introduction of modern streetcar vehicles in North America.

The project is being undertaken by the APTA Streetcar Subcommittee. The Subcommittee welcomes the participation of interested parties. An initial version of this outline was discussed during the Subcommittee's meeting in Seattle, Washington on January 24, 2010. Additional information about the project's progress and upcoming meetings is available on the project website at [www.modernstreetcar.org](http://www.modernstreetcar.org). Please send comments on this draft document to project manager John Smatlak at [info@modernstreetcar.org](mailto:info@modernstreetcar.org)



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<b>1. Vehicle Configuration</b>		
1.1 Duty Cycle		
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1.3 Optimizing the Vehicle for the Streetcar Operating Environment		
1.3.1 Leading End Design		
1.3.2 Recovery Provisions		
1.3.3 Forward and Side Visibility		
1.3.4 External Lighting		
1.3.5 Train to Wayside Communication (TWC)		
1.3.6 Audible Warnings		
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1.4 Partial versus 100% Low-Floor		
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Carbuilder Survey		
Level Boarding Platform- Best Practices		

**Potential list of terms to be included in Glossary**

- |                               |                                  |                                       |
|-------------------------------|----------------------------------|---------------------------------------|
| 100% low-floor                | Gong                             | PCC                                   |
| ADA                           | Ground Level Power System (GLPS) | Side platform                         |
| Bridgeplate                   | Hybrid vehicle                   | Single-ended vehicle                  |
| CCTV                          | Island platform                  | Single-sided vehicle                  |
| Center platform               | Legacy system                    | Streetcar                             |
| Developed kinematic envelope  | Level boarding                   | Traction Electrification System (TES) |
| Diesel Light Rail Vehicle     | Light Rail                       | Traction Power System (TPS)           |
| Double-ended vehicle          | Nearly Level boarding            | Train to Wayside Communication (TWC)  |
| Double-sided vehicle          | Off-Wire Capable Vehicle         |                                       |
| Emergency Off-Wire Capability | Overhead Contact System (OCS)    |                                       |
| End change                    | Partial low-floor                |                                       |
| Fully Level boarding          |                                  |                                       |



## Available Resources- Background Research

- “Overview of Cross Section Design Elements” Hall, Powers, Turner, Brilon, Hall, Conference Proceedings, 1995 International Symposium on Highway Geometric Design Practices.
- “Making Transit Work” Insight from Western Europe, Canada, and the United States” TRB Special Report 257, 2001
- “Mobility 2001- World Mobility at the End of the Twentieth Century and its Sustainability, Chapter 3: Personal Mobility in the Urbanized Developed World” World Business Council for Sustainable Development 2001.
- TCRC Research Results Digest March 2002-Number 47, “International Transit Studies Program, Germany’s Track-Sharing Experience: Mixed Use of Rail Corridors”
- “Comparative Performance Data from French Tramways Systems” South Yorkshire Passenger Transport Executive, SEMALY & FaberMaunsell, December 2003
- “Walking, Cycling, and Obesity Rates in Europe, North America, and Australia” David R. Bassett, Jr., John Pucher, Ralph Buehler, Dixie L. Thompson, and Scott E. Crouter 2008
- “Making Transportation Sustainable: Insights from Germany”, Ralph Buehler, John Pucher, and Uwe Kunert, Brookings Institution Metropolitan Policy Program, April 2009
- “Stainless Steel Helps Prevent Deicing Salt Corrosion” Houska, TMR Stainless IMOA newsletter
- “Sustainable Transport that Works” Ralph Buehler, John Pucher, World Transport Policy & Practice, April 2009



## Available Resources Topic 1- Vehicle Configuration

- “Light Rail Transit, State of the Art Review”, Chapter 5 “Light Rail Vehicles” USDOT, 1976
- Transit Performance newsletter “How to Fit a Larger LRV into a Restricted Wayside Clearance” DDE Press September, 1991
- Transit Performance newsletter “Low Floor LRVs Take Over the Market” DDE Press September, 1994
- “Stadtbahnen in Deutschland” (“Light Rail in Germany”) Book, VDV 2000
- EC OIM Report 2000, Sections 7.13 Vehicle Dimensions, 7.14 Vehicle Layout
- LibeRTiN Draft Report on Topic “Vehicle Width, Height and Length” 2003
- LibeRTiN Draft Report on Topic “Door Systems” 2003
- LibeRTiN Draft Report on Topic “Internal Layout” 2003
- “Light Rail Vehicles’ Low-Floor Center Section” Morgan, TRB 9th National LRT Conference
- “The Development of the Modern Tram” Book, Brian Patton, 2006
- DIN 5566, Railway Vehicles, Driver’s Cabs 2006
- TTC “Analyses Leading to Specifying a 100% Low Floor Light Rail Vehicle for TTC’s Existing Surface Rail Network” 10/29/07
- “Low-Floor and High-Floor Vehicle Characteristics and System Implications” LRT Technology Forum, Background Papers, City of Ottawa, June 2009
- “Long Term Orders Dominate the Market” H. Hondius, article in Metro Report International, 2010
- “Tram Design and Construction, supporting guidance to RSP2 Section 8” UK Office of Rail Regulation 2010



## Available Resources for Topic 2- Vehicle / Platform Interface

- “Stadtbahnen in Deutschland” (“Light Rail in Germany”) Book, VDV 2000. Chapter 5 “Light Rail Stops”
- UK “Guidance on Tramways”, Chapter 5 “Tram Stops”
- VDV BOStrab Section 31 “Stopping Places”
- EC OIM Report 2000, Sections 7.13 Vehicle Dimensions, 7.14 Vehicle Layout
- Passenger Access Considerations for Low-Floor Light Rail Vehicles, TRB, Pearson, 2000
- LibeRTiN Topic Report “Access” 2003
- LibeRTiN Draft Report on Topic “Disabled Person Provisions” 2003
- LibeRTiN Draft Report on Topic “Door Systems” 2003
- “Barrier Free Public Transport in Germany” VDV 2003
- Transport for London “Accessible Bus Stop Design Guidance” 2006
- Paragraph from TRB “Trackway Infrastructure Guidelines for Light Rail Circulator Systems”, excerpt from Part 7 “Compatibility of LRT and Light Rail Circulator Systems” Graebner, Jackson, Lovejoy 2007
- PT Access- “State of the Accessibility of Public Transport Systems for People with Disabilities in Europe” 2007
- US Access Board- Subpart D “Light Rail Vehicles and Systems” and Chapter 10 “Transportation Facilities”
- “Innovative Design for Safe and Accessible Light Rail or Tram Stops Suitable for Streetcar-Style Conditions” TRB, Currie, Smith 2007
- “Local and Regional Railway Tracks in Germany” VDV 2007, Chapter 3.6
- APTA “Recommended Practices for the Vehicle and Station Platform Interface on Bus Rapid Transit Systems”. Draft 2008
- “Assessing the Gap Between Public Transport Vehicles and Platforms as a Barrier for the Disabled: Use of Laboratory Experiments”, Daamen, de Boer, de Kloe, TRB 2008
- “Design of Stops and Stations for Level-Access of Busses and Tramways” R. Fischer, 6<sup>th</sup> Framework Programme, SPUTNIC
- Brett Landscaping “The Kassel Kerb System” brochure 2010



- “Client Design Requirements for Accessible Tram Stops” Victoria Department of Transport, 2010

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### Available Resources for Topic 3- Vehicle / Track Interface

- Transit Transit Performance newsletter “Low Floor LRVs Take Over the Market” DDE Press September, 1994
- TCRP Report 2: “Applicability of Low Floor Light Rail Vehicles in North America” 1995
- TCRP Report 57: Track Design Handbook for Light Rail Transit 2000 (Note: second edition now in development, due for 2012 release)
- LibeRTiN Topic Report “Derailment Prevention and Ride Quality” 2003
- “Integrating New Light Rail Vehicle Technology into Mature Infrastructure” Fraser, Leary, Marianeschi, Pellegrini, TRB 9th National LRT Conference
- VDV “Spurfuerungsrichtlinien”, English translation (German regulations on wheel-rail interface)
- VDV “Trassierungsrichtlinien” (German regulations, contains recommended values for track geometry)
- Center Truck Performance on Low-Floor Light Rail Vehicles, TCRP Report 114, 2006
- “Introducing New Light Rail Rolling Stock on to Old Track” Mau, Fraser, AREMA 2006 Annual Conference
- “Trackway Infrastructure Guidelines for Light Rail Circulator Systems” Graebner, Jackson, Lovejoy, 2007
- “Optimal Design of Low-Floor Tram”, Capek, Kolar 2007
- TTC “Analyses Leading to Specifying a 100% Low Floor Light Rail Vehicle for TTC’s Existing Surface Rail Network” 10/29/2007
- “Local and Regional Railway Tracks in Germany” Book, VDV 2007
- “Rotating Bogies in Low Floor Trams” Zelingr, Heptner 2009
- VDV- Additional English translations of BoStrab, available on the UK Office of Rail Regulation website, “Tramway Technical Guidance Notes” page, 2010



#### Available Resources for Topic 4- Power Supply

- LibeRTiN Draft Report on Topic “Compatibility of Energy Supply Systems” 2003
- LibeRTiN Draft Report on Topic “Safety of Energy Supply Systems” 2003
- “Tramways Cut the Cord” Didier Fremaux, UIPT PTI September/October 2008 issue
- “Energy Storage Technology, Honolulu High-Capacity Transit Corridor Project” John Swanson, PB Americas, April 2008
- “Streetcar Technology Assessment” City of Charlotte, May 2010
- “Analyzing the Potential of Energy Storage on Electrified Transit Systems” M. Chymera, A.C. Renfrew, M. Barnes. 2010
- “Overhead Wires Free Light Rail Systems” M. Novales, TRB 2011 Annual Meeting
- “Energy Recovery, Overview of Braking Energy Recovery Technologies in the Public Transport Field”. Ticket to Kyoto, Deliverable 1, March 2011

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## Available Resources for Topic 5- Standards

### Standards:

#### *General Standards:*

- “Consensus Standards for the Rail Transit Industry” TCRP Research Results Digest 44, 2001

#### *ADA*

- US Access Board- Subpart D “Light Rail Vehicles and Systems” and Chapter 10 “Transportation Facilities”
- “Coordinated Approaches to Expanding Access to Public Transportation” TCRP Research Results Digest 81, February 2007
- “The gap between vehicle and platform as a barrier to the disabled; an effort to empirically relate the gap size to the difficulty of bridging it” Transed 2007 Canada
- PT Access website and reports- Public Transport System’s Accessibility for People with Disabilities in Europe (includes individual country reports 2008)
- “Disabled Persons Transport” UK regulation 2010
- LibeRTiN Topic Report “Access” 2003
- LibeRTiN Draft Report on Topic “Disabled Person Provisions” 2003

#### *Crashworthiness*

- TCRP Synthesis of Transit Practice 25, “Light Rail Vehicle Compression Requirements” Lewalski, 1997
- ASME RT-1 “Safety Standard for Structural Requirements for Light Rail Vehicles”
- “Collision Safety Improvements for Light Rail Vehicles Operating in Shared Right-of-Way Street Environments” FTA publication FTA-CA-26-7007.2010.1, September 30, 2009
- EN 15227 “Crashworthiness Requirements for Railway Vehicle Bodies”
- LibeRTiN Draft Report on Topic “Crashworthiness” 2003
- SAFETRAM project



- “LRV Statistics, Passive Safety in Urban Railway Systems, Light Rail Vehicle (LRV)- Accident Statistics”. IST and TUB, December 2000
- “Structural and Crashworthiness Requirements of Light Rail Vehicles with Low-Floor Extension” Sarunac, Zeolla, TRB 9th National LRT Conference
- North American First Crashworthy 70% Low Floor Light Rail Vehicle, Canjea, 2006
- TCRP Research Results Digest 85, International Transit Studies Program, “Rail Passenger Safety: Equipment and Technologies” August 2007
- Comparison of Current Draft of ASME “Safety Standard for Structural Requirements for Light Rail Vehicles” and Current European Standards EN 12663 “Structural Requirements of Railway Vehicle Bodies” and EN 15227 “Crashworthiness Requirements of Railway Vehicle Bodies” Stong, 2008
- “Collision Safety Improvements for LRVs Operating in Shared Right of Way Street Environments” FTA-CA-26-7007.2010.1 September 2009

#### *Braking Rates*

- CPUC General Order 143-B governing Light Rail operation in California, Section 4 “Brakes on Light Rail Vehicles”.
- VDV BOStrab Braking Regulations- English version
- EN 13452-1 Braking Requirements and EN 13452-2 Testing Methods
- LibeRTiN Draft Report on Topic “Emergency Braking” 2003
- EC OIM Report 2000, Section 7.8 “Emergency Braking”
- SAFETRAM project

#### *Fire Safety*

- LibeRTiN Report on Topic “Fire Safety” 2003
- NFPA 130
- prEN 45545
- “Concepts for Fire Protection of Passenger Rail Transportation Vehicles, Past, Present and Future”, Peacock, Reneke, Jones, Bukowski, Babrauskas, 1994. See also “Fire Safety of Passenger Trains” NIST Technical Note 1406

