

# Automated People Mover Standards—Part 3

Electrical  
Stations  
Guideways

This document uses both the  
International System of Units (SI)  
and customary units

**American Society of Civil Engineers**

# **Automated People Mover Standards—Part 3**

This document uses both the International System of Units (SI) and customary units.

**Electrical  
Stations  
Guideways**



**Published by the American Society of Civil Engineers**

## Library of Congress Cataloging-in-Publication Data

Automated people mover/American Society of Civil Engineers.  
p. cm.  
ISBN 0-7844-0873-4  
1. Personal rapid transit. I. American Society of Civil Engineers.

TA1207.A95 2006  
625.4—dc22

2006017165

Published by American Society of Civil Engineers  
1801 Alexander Bell Drive  
Reston, Virginia 20191  
www.pubs.asce.org

This standard was developed by a consensus standards development process which has been accredited by the American National Standards Institute (ANSI). Accreditation by ANSI, a voluntary accreditation body representing public and private sector standards development organizations in the U.S. and abroad, signifies that the standards development process used by ASCE has met the ANSI requirements for openness, balance, consensus, and due process.

While ASCE's process is designed to promote standards that reflect a fair and reasoned consensus among all interested participants, while preserving the public health, safety, and welfare that is paramount to its mission, it has not made an independent assessment of and does not warrant the accuracy, completeness, suitability, or utility of any information, apparatus, product, or process discussed herein. ASCE does not intend, nor should anyone interpret, ASCE's standards to replace the sound judgment of a competent professional, having knowledge and experience in the appropriate field(s) of practice, nor to substitute for the standard of care required of such professionals in interpreting and applying the contents of this standard.

ASCE has no authority to enforce compliance with its standards and does not undertake to certify products for compliance or to render any professional services to any person or entity.

ASCE disclaims any and all liability for any personal injury, property damage, financial loss or other damages of any nature whatsoever, including without limitation any direct, indirect, special, exemplary, or consequential damages, resulting from any person's use of, or reliance on, this standard. Any individual who relies on this standard assumes full responsibility for such use.

ASCE and American Society of Civil Engineers—Registered in U.S. Patent and Trademark Office.

*Photocopies and reprints.* You can obtain instant permission to photocopy ASCE publications by using ASCE's online permission service (<http://pubs.asce.org/permissions/requests/>). Requests for 100 copies or more should be submitted to the Reprints Department, Publications Division, ASCE (address above); email: [permissions@asce.org](mailto:permissions@asce.org). A reprint order form can be found at <http://pubs.asce.org/support/reprints/>.

Copyright © 2008 by the American Society of Civil Engineers.  
All Rights Reserved.  
ISBN 13: 978-0-7844-0954-1  
ISBN 10: 0-7844-0954-4  
Manufactured in the United States of America.

16 15 14 13 12 11 10 09 08 1 2 3 4 5

## STANDARDS

In 2003, the Board of Direction approved the revision to the ASCE Rules for Standards Committees to govern the writing and maintenance of standards developed by the Society. All such standards are developed by a consensus standards process managed by the Society's Codes and Standards Committee (CSC). The consensus process includes balloting by a balanced standards committee made up of Society members and nonmembers, balloting by the membership of the Society as a whole, and balloting by the public. All standards are updated or reaffirmed by the same process at intervals not exceeding five years.

The following standards have been issued:

- ANSI/ASCE 1-82 N-725 Guideline for Design and Analysis of Nuclear Safety Related Earth Structures
- ASCE/EWRI 2-06 Measurement of Oxygen Transfer in Clean Water
- ANSI/ASCE 3-91 Standard for the Structural Design of Composite Slabs and ANSI/ASCE 9-91 Standard Practice for the Construction and Inspection of Composite Slabs
- ASCE 4-98 Seismic Analysis of Safety-Related Nuclear Structures
- Building Code Requirements for Masonry Structures (ACI 530-02/ASCE 5-02/TMS 402-02) and Specifications for Masonry Structures (ACI 530.1-02/ASCE 6-02/TMS 602-02)
- ASCE/SEI 7-05 Minimum Design Loads for Buildings and Other Structures
- SEI/ASCE 8-02 Standard Specification for the Design of Cold-Formed Stainless Steel Structural Members
- ANSI/ASCE 9-91 listed with ASCE 3-91
- ASCE 10-97 Design of Latticed Steel Transmission Structures
- SEI/ASCE 11-99 Guideline for Structural Condition Assessment of Existing Buildings
- ASCE/EWRI 12-05 Guideline for the Design of Urban Subsurface Drainage
- ASCE/EWRI 13-05 Standard Guidelines for Installation of Urban Subsurface Drainage
- ASCE/EWRI 14-05 Standard Guidelines for Operation and Maintenance of Urban Subsurface Drainage
- ASCE 15-98 Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installations (SIDD)
- ASCE 16-95 Standard for Load Resistance Factor Design (LRFD) of Engineered Wood Construction
- ASCE 17-96 Air-Supported Structures
- ASCE 18-96 Standard Guidelines for In-Process Oxygen Transfer Testing
- ASCE 19-96 Structural Applications of Steel Cables for Buildings
- ASCE 20-96 Standard Guidelines for the Design and Installation of Pile Foundations
- ANSI/ASCE/T&DI 21-05 Automated People Mover Standards—Part 1
- ASCE/T&DI 21.2-08 Automated People Mover Standards—Part 2
- ANSI/ASCE/T&DI 21.3-08 Automated People Mover Standards—Part 3
- ANSI/ASCE/T&DI 21.4-08 Automated People Mover Standards—Part 4
- SEI/ASCE 23-97 Specification for Structural Steel Beams with Web Openings
- ASCE/SEI 24-05 Flood Resistant Design and Construction
- ASCE/SEI 25-06 Earthquake-Actuated Automatic Gas Shutoff Devices
- ASCE 26-97 Standard Practice for Design of Buried Precast Concrete Box Sections
- ASCE 27-00 Standard Practice for Direct Design of Precast Concrete Pipe for Jacking in Trenchless Construction
- ASCE 28-00 Standard Practice for Direct Design of Precast Concrete Box Sections for Jacking in Trenchless Construction
- ASCE/SEI/SFPE 29-05 Standard Calculation Methods for Structural Fire Protection
- SEI/ASCE 30-00 Guideline for Condition Assessment of the Building Envelope
- SEI/ASCE 31-03 Seismic Evaluation of Existing Buildings
- SEI/ASCE 32-01 Design and Construction of Frost-Protected Shallow Foundations
- EWRI/ASCE 33-01 Comprehensive Transboundary International Water Quality Management Agreement
- EWRI/ASCE 34-01 Standard Guidelines for Artificial Recharge of Ground Water
- EWRI/ASCE 35-01 Guidelines for Quality Assurance of Installed Fine-Pore Aeration Equipment
- CI/ASCE 36-01 Standard Construction Guidelines for Microtunneling
- SEI/ASCE 37-02 Design Loads on Structures During Construction
- CI/ASCE 38-02 Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data
- EWRI/ASCE 39-03 Standard Practice for the Design and Operation of Hail Suppression Projects
- ASCE/EWRI 40-03 Regulated Riparian Model Water Code
- ASCE/SEI 41-06 Seismic Rehabilitation of Existing Buildings
- ASCE/EWRI 42-04 Standard Practice for the Design and Operation of Precipitation Enhancement Projects
- ASCE/SEI 43-05 Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities
- ASCE/EWRI 44-05 Standard Practice for the Design and Operation of Supercooled Fog Dispersal Projects
- ASCE/EWRI 45-05 Standard Guidelines for the Design of Urban Stormwater Systems
- ASCE/EWRI 46-05 Standard Guidelines for the Installation of Urban Stormwater Systems
- ASCE/EWRI 47-05 Standard Guidelines for the Operation and Maintenance of Urban Stormwater Systems
- ASCE/SEI 48-05 Design of Steel Transmission Pole Structures

*This page intentionally left blank*

## FOREWORD

The Board of Direction approved revisions to the ASCE Rules for Standards Committees to govern the writing and maintenance of standards developed by ASCE. All such standards are developed by a consensus standards process managed by the ASCE Codes and Standards Committee (CSC). The consensus process includes balloting by a balanced standards committee, and reviewing during a public comment period. All standards are updated or reaffirmed by the same process at intervals of between five and ten years.

This standard is Part 3 of the four-part Automated People Mover Standards, which establish the minimum set of requirements necessary to achieve an acceptable level of safety and performance for an Automated People Mover (APM) system. An APM is defined as a guided transit mode with fully automated operation, featuring vehicles that operate on guideways with exclusive right-of-way.

Parts 1, 2, and 3 cover requirements for design of an APM system while Part 4 covers requirements for an APM in passenger operation. Part 3 contains sections covering electrical, stations, and guideways.

The ASCE Automated People Movers Standards Committee has been developing these standards since 1991. The committee comprises individuals from many backgrounds, including consulting engineering, research, transit agencies, airports, transit system design and manufacturing, education, government, and private practice.

This standard establishes the minimum set of requirements necessary to achieve an acceptable level of

safety and performance for an APM system. As such, it may be used in the safety certification process. The overall goal of this standard is to assist the industry and the public by establishing standards for APM systems.

This standard has no legal authority in its own right but may acquire legal standing in one or more of the following ways:

1. Adoption by an authority having jurisdiction.
2. Reference to compliance with the standard as a contract requirement.
3. Claim by a manufacturer or manufacturer's agent of compliance with the standard.

This standard will be beneficial to transportation engineers, civil engineers, safety engineers, and contractors of APM systems. Anyone who owns, operates, builds or maintains, designs, tests, insures, oversees, or certifies APMs or other innovative technology transit systems such as magnetic levitation, air cushion, and monorail systems will also benefit from the standard.

This standard has been prepared in accordance with recognized engineering principles and should not be used without the user's competent knowledge for a given application. The publication of this standard by ASCE is not intended to warrant that the information contained therein is suitable for any general or specific use, and ASCE takes no position respecting the validity of patent rights. The user is advised that the determination of patent rights or risk of infringement is entirely their own responsibility.

*This page intentionally left blank*

## ACKNOWLEDGMENTS

The American Society of Civil Engineers (ASCE) acknowledges the devoted efforts of the Automated People Mover Standards Committee under the Codes and Standards Committee. This group comprises individuals from many backgrounds, including consulting engineering, research, transit agencies, airports, transit system design and manufacturing, education, government, regulatory agencies, and private practice.

Thomas McGean, P.E., *Chair*  
Lawrence Smith, P.E., *Secretary*  
Tedd Snyder, P.E., *Vice-Chair*  
Joseph Abbas  
Douglas Baird  
Frank Bares  
Cheryl Boehm  
Murthy Bondada, P.E.  
Jon Brackpool  
Pierre Brunet  
David Campbell, P.E.  
John Champ  
Yves Clarissou  
Redjean Clerc  
Frank Culver  
Peter DeLeonardis  
Paul Didrikson, P.E.  
Didier Dupre  
Charles Elms, P.E.  
Robert Falvey  
Jimmy Fletcher, P.E.  
Matthias Frenz  
Henri Frey, P.E.  
Darin Friedmann  
Antonio Garcia  
Franklin Gates  
Robert Griebenow, P.E.  
Greg Hale  
Albert Hartkorn  
William Hathaway  
James Hoelscher  
Gary Houts, P.E.  
Victor Howe  
Alex Inserto

This standard was prepared through the consensus standards process by balloting in compliance with procedures of ASCE's Codes and Standards Activity Council. Those individuals who serve on the Automated People Mover Standards Committee are:

James Johnson  
Dieter Jussel  
Ronald Kangas  
John Kapala  
Alexander Klimmer, P.E.  
Kyle Kraudy  
Jun-Ho Lee  
J. Sam Lott, P.E.  
Martin Lowson  
Stanford Lynch, P.E.  
Charles Martin  
David Mason  
Frank Mauderer  
J. David Mori, P.E.  
Diane Morse  
Jorg Nahke  
Josef Nejez  
Hiroshi Ogawa, P.E.  
Richard Prell  
Felix Rhyner  
Michael Riseborough  
William Rourke  
Obe Schrader  
William Showalter  
Michael Shumack  
David Taliaferro  
David Thurston  
James Tuten, P.E.  
Gert Vestergaard  
Rudiger Vom Hovel  
Thomas Waldron  
Ray Warner, P.E.  
Ken Williams

The following Working Group Leaders are especially acknowledged for their efforts in drafting specific sections of the standard and shepherding them through the consensus process:

- WG1—General, Robert Good; Reaffirmation, Michael Shumack and Thomas McGean
- WG2—Definitions, Edward S. Neumann; Reaffirmation, Thomas McGean
- WG12—Electrical, Joseph Abbas; Reaffirmation, Joseph Abbas with Alex Inserto
- WG4—Stations, William Hathaway, J. Sam Lott, Jimmy Fletcher, and Thomas McGean; Reaffirmation, Jimmy Fletcher with William Hathaway
- WG8—Guideways, Reuben Beebe, David Campbell, Jimmy Fletcher, Robert Griebenow, Jim

Harper, J. Sam Lott, and William Hathaway; Reaffirmation, Robert Griebenow with William Hathaway

ASCE Staff support was provided by Jon Esslinger with Phillip Mariscal. Michael Shumack provided Configuration Control and Web site support. Support for our membership mailings and communication was provided by Frank Culver and Lawrence Smith. Support for meetings was provided by Berger/Abam Engineers; Bombardier Transportation; Booz Allen Hamilton; Conductix; Dallas/Fort Worth International Airport; Doppelmayr Cable Car; Japan Overseas Rolling Stock Corporation; KBR; Lea+Elliott; Mitsubishi Heavy Industries; Becky Perry and Lawrence Smith; Slattery Skanska; Sumitomo; Tampa International Airport; and *The Queens Courier*.

## CONTENTS

1.	GENERAL .....	1
	1.1 SCOPE .....	1
	1.2 EXISTING APPLICATIONS .....	1
	1.3 NEW APPLICATIONS .....	1
	1.4 REFERENCE STANDARDS .....	1
	1.5 DEFINITIONS .....	2
9.	ELECTRICAL EQUIPMENT .....	3
	9.1 GENERAL .....	3
	9.1.1 Safety .....	3
	9.1.2 Corrosion Control .....	4
	9.1.3 Electrical System Protection .....	4
	9.1.4 Grounding .....	4
	9.1.5 Redundancy .....	5
	9.1.6 Design Life .....	5
	9.1.7 Voltage Regulation .....	5
	9.1.8 Capacity .....	5
	9.2 TRACTION POWER SUBSTATION EQUIPMENT .....	5
	9.2.1 Interfaces with the Local Utility Company .....	5
	9.2.2 Power Factor .....	5
	9.2.3 Harmonics .....	5
	9.2.4 System Monitoring and Alarms .....	5
	9.2.5 Power Regeneration Equipment .....	6
	9.2.6 Remote Monitoring and Control .....	6
	9.2.7 Local Control .....	6
	9.2.8 Restoring Power .....	6
	9.2.9 Substation Facilities .....	6
	9.3 WAYSIDE POWER COLLECTION .....	6
	9.3.1 Guideway Mounted Power Distribution .....	6
	9.3.2 Power Zones .....	6
	9.3.3 Splice Joint Requirements .....	7
	9.3.4 Expansion Joints/Sections .....	7
	9.3.5 Power Rail Transitions .....	7
	9.3.6 Insulators .....	7
	9.3.7 Mounting .....	7
	9.3.8 Power Rail to Earth Resistance .....	7
	9.3.9 Power and Ground Rail Heating .....	7
	9.4 PASSENGER STATION ELECTRICAL EQUIPMENT .....	7
	9.5 UNINTERRUPTIBLE POWER SUPPLY .....	7
10.	STATIONS .....	7
	10.1 DISABLED PERSONS ACCESS REQUIREMENTS .....	8
	10.1.1 Vehicle–Platform Gap .....	8
	10.1.2 Detectable Warning Strip .....	8
	10.2 PLATFORM EDGE PROTECTION .....	8
	10.2.1 Intrusion Prevention System .....	8
	10.2.2 Intrusion Control System .....	9
	10.2.3 Intrusion Detection System .....	10

10.3	EVACUATION OF MISALIGNED TRAINS .....	10
10.4	EMERGENCY LIGHTING AND VENTILATION .....	10
10.5	FIRE PROTECTION .....	10
10.5.1	Fire Detection .....	10
10.5.2	Fire Containment .....	10
10.5.3	Fire Suppression .....	10
11.	GUIDEWAYS .....	10
11.1	BLUE LIGHT STATIONS .....	11
11.2	INTRUSION PROTECTION AND DETECTION .....	11
11.3	EMERGENCY EVACUATION AND ACCESS .....	11
11.3.1	Tunnel Guideway .....	11
11.3.2	Surface Guideway .....	11
11.3.3	Elevated Guideway .....	11
11.4	FIRE PROTECTION .....	12
11.5	SIGNAGE .....	12
11.6	EMERGENCY LIGHTING AND VENTILATION .....	12
11.7	EMERGENCY POWER SUPPLY .....	12
11.8	GUIDEWAY ALIGNMENT .....	12
11.8.1	Clearances .....	13
11.8.2	Operating Equipment Interfaces .....	13
11.8.3	Drainage .....	13
11.9	STRUCTURAL CRITERIA .....	13
11.9.1	Loads and Forces .....	13
11.9.2	Load Combinations .....	15
11.9.3	Design and Analysis .....	15
INDEX	.....	17

# Automated People Mover Standards—Part 3

## 1. GENERAL

### 1.1 SCOPE

This standard has been divided into four parts to expedite the approval and release process as well as to facilitate ease of use. This document constitutes Part 3 of the standard.

Parts 1, 2, and 3 cover a minimum set of requirements for design of an Automated People Mover (APM) with an acceptable level of safety and performance.

Part 1 consists of:

1. General
2. Operating Environment
3. Safety Requirements
4. System Dependability
5. Automatic Train Control (ATC)
6. Audio and Visual Communications

Part 2 consists of:

1. General
7. Vehicles
8. Propulsion and Braking

Part 3 consists of:

1. General
9. Electrical
10. Stations
11. Guideways

Part 4 is a minimum set of requirements for maintaining an acceptable level of safety and performance for an APM in passenger operation.

Part 4 consists of:

1. General
12. Security
13. Emergency Preparedness
14. System Verification and Demonstration
15. Operations, Maintenance, and Training
16. Operational Monitoring

The APM Standards all use SI units with equivalent English units provided in parentheses.

### 1.2 EXISTING APPLICATIONS

Existing installations and projects in progress before the effective date of this standard need not comply with the new or revised requirements of this edition,

except where specifically required by the authority having jurisdiction. Existing APMs, when removed and reinstalled, shall be classified as new installations.

### 1.3 NEW APPLICATIONS

New installations begun after the effective date of this standard shall comply with the new or revised requirements of this edition.

### 1.4 REFERENCE STANDARDS

The following documents or portions thereof are incorporated by reference in this standard:

**AASHTO:** American Association of State Highway and Transportation Officials, Suite 249, 444 North Capitol Street NW, Washington, DC 20001; phone (202) 624-5806.

*AASHTO LRFD Bridge Design Specifications*, 4th edition, 2007 (cited in 11.9.1, 11.9.2, and 11.9.3)

*AASHTO Standard Specifications for Highway Bridges*, 17th edition, 2002 (cited in 11.9.1, 11.9.2, and 11.9.3).

**ASCE:** American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, VA 20191; phone (703) 295-6163.

ANSI/ASCE/T&DI 21-05, *Automated People Mover Standards—Part 1* (cited in 9.1.3, 9.1.4, 9.1.4.2, 9.1.5, 9.2.3, 9.2.4, 9.2.5, 9.2.6, 9.2.8, 9.2.9, 9.5, 10.2, 10.2.1, 10.2.2, 10.2.3, 10.3, 10.5.1, 10.5.2, 11.1, 11.2, 11.3, 11.3.3, 11.8.1, 11.8.3, and 11.9.1)

ASCE/T&DI 21.2-08, *Automated People Mover Standards—Part 2* (cited in 9.1.4, 9.1.8, 10.1.1, 10.2.1, 10.2.2, 10.2.3, 11.8 11.8.1, and 11.9.3)

**ANSI:** American National Standards Institute, Customer Service, 25 West 43rd Street, 4th floor, New York, NY 10036; phone (212) 642-4980.

ANSI B77.1-2006, *Passenger Ropeways, Aerial Tramways, Aerial Lifts, Surface Lifts, Tows and Conveyors—Safety Requirements* (cited in 11.0)

ANSI Z97.1-2004, *Safety Glazing Materials Used in Buildings—Safety Performance Specifications and Methods of Test* (cited in 10.2.1 and 10.2.2)

ANSI 117.1-2003, *Guidelines for Accessible and Useable Buildings and Facilities* (cited in 11.5)

**ASTM:** American Society of Testing Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959; phone (610) 832-9585.