Designation: E 985 – 00 (Reapproved 2006)

Standard Specification for Permanent Metal Railing Systems and Rails for Buildings[1]

This standard is issued under the fixed designation E 985; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification[2] covers permanent metal railing systems (guard, stair, and ramp-rail systems) and rails (hand, wall, grab, and transfer rails) installed in and for agricultural, assembly, commercial, educational, industrial, institutional, recreational, and residential buildings.

1.2 This specification is intended to be applied to permanent metal railing systems for buildings and to such railing systems and rails having major structural components made of metal, with their secondary components made of metal or other materials such as wood, plastics, and glass.

1.3 This specification considers that today's and tomorrow's overall outlook is based on the health and safety of all potential users of buildings. The criteria incorporated in this specification provide for normal and anticipated building uses, but not for abuses for which the building and its components are not designed.

1.4 This specification establishes basic minimum requirements and criteria that lead to satisfactory products under normal use conditions and does not give consideration to design criteria for specific field conditions, the establishment of which is the prerogative and responsibility of the designer, specification writer, and code agencies.

1.5 Sources of supportive information are listed in the Reference section (**1-28**).[3]

1.6 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [4]

E 631 Terminology of Building Constructions

E 894 Test Method for Anchorage of Permanent Metal Railing Systems and Rails for Buildings

E 935 Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings

E 1481 Terminology of Railing Systems and Rails for Buildings

3. Terminology

3.1 *Definitions*—For definitions of terms covering railing systems and rails for buildings, see Terminology E 631 and Terminology E 1481.

4. Design Requirements

4.1 *Railing Height*:

4.1.1 *Guardrail Systems*:

4.1.1.1 The fabricated height of a guardrail system, measured from its top surface to the finished floor level, shall be a minimum of 1.07 m (42 in.). When variations in the evenness of the finished floor will result in individual height measurements of the installed guardrail system to be less than 1.04 m (41 in.), the fabricated height of the guardrail system shall be increased accordingly.

4.1.1.2 Within an individual dwelling unit, the required railing height is reduced.

(a) Where the vertical distance between adjacent finished floor levels is less than 1.83 m (72 in.), the height shall be a minimum of 0.81 m (32 in.). When variations in the evenness of the finished floor will result in individual height measurements of the installed guardrail system to be less than 0.79 m (31 in.), the fabricated height of the guardrail system shall be increased accordingly.

(b) Where the vertical distance between adjacent finished floor levels is a minimum of 1.83 m (72 in.), the height shall be a minimum of 0.86 m (34 in.). When variations in the evenness

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[2] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR: E06-1000.

[3] The boldfaced numbers in parentheses refer to the list of references at the end of this specification.

[4] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

of the finished floor will result in individual height measurements of the installed guardrail system to be less than 0.84 m (33 in.), the fabricated height of the guardrail system shall be increased accordingly.

4.1.1.3 In public assembly, elementary school, and multiple-family occupanies where the vertical distance between stair and adjacent levels is more than 4.1 m (20 ft), the required railing height shall be increased beyond that given in 4.1.1.1.

4.1.1.4 For balconies in public-assembly occupancies, the required railing height in front of the first row of fixed seats shall be reduced to 0.66 m (26 in.) provided adequate safety is established by the designer and approved by the authority having jurisdiction; however, it shall be a minimum of 0.91 m (36 in.) at aisle ends and a minimum of 1.07 m (42 in.) where aisle steps occur.

4.1.2 *Handrails and Stair-Rail Systems*:

4.1.2.1 In corridors, ramps, walkways, and enclosed stairways having a slope of at least 1 in 20, the height of the handrail of the stair-rail systems, measured from its top surface to the finished floor level or tread-nose line, shall be not less than 0.86 m (34 in.) nor more than 0.97 m (38 in.). When a stair-rail system is higher than 0.97 m (38 in.), a separate handrail shall be installed at a height of not less than 0.86 m (34 in.) nor more than 0.97 m (38 in.).

4.1.2.2 Where required and in childcare and educational facilities serving children under the age of 12 years, a second separate handrail shall be permitted to be installed at a mounting height of 24 to 28 in. (610 to 710 mm). The vertical clearance between the handrails shall be at least 9 in. (230 mm).

4.1.3 *Transfer Rail Systems*—Where transfer rail systems are to be installed, such as in toilets and bathrooms, the required height, measured from its top surface to the finished floor level, shall not be less than 0.76 m (30 in.) nor more than 0.86 m (34 in.).

4.2 *Railing System Penetration*:

4.2.1 The various members of the railing system shall be arranged such that a sphere, 140 mm (5½ in.) in diameter, cannot be passed through any opening in the system except as noted in 4.2.2. The members shall be arranged to discourage climbing.

4.2.2 In areas protected by a railing system where children five years of age or less will be present or have access and require protection from passing through the railing system, the various members of the railing system, such as balusters, screens, wire mesh, or scrolls, shall be arranged in such a way that a sphere, 102 mm (4 in.) in diameter cannot be passed through any opening in the system up to a height of 0.66 m (26 in.) above the top surface of the adjacent finished floor.

4.2.3 In industrial, commercial, and other nonresidential occupancies, where only adults normally will be present or have access, and in areas where access by the users is infrequent, the diameter of the sphere may be increased to 533 mm (21 in.) unless other conditions warrant a smaller diameter.

4.2.4 Toe boards shall be provided in areas where tools and other objects could be dislodged and fall on occupants below. The top of the toe board shall not be less than 102 mm (4 in.) and the bottom not more than 13 mm (½ in.) above the average finished level at the line of the vertical supports of the railing system.

4.3 *Handrail Design*:

4.3.1 Handrails shall be designed to permit continuous sliding of hands. The hardware chosen for attaching handrails to balusters or walls shall be such that projecting lugs, devices, or other construction elements shall have no sharp edges or dangerous protrusions.

4.3.2 Handrail ends shall be returned to supporting walls or otherwise arranged to avoid projecting rail ends. Wall handrails at stairs and ramps and other handrails that are not continuous shall be extended horizontally for a distance of at least 305 mm (12 in.) beyond the intersection of the finish line (plane of thread nose lines) of the stair or ramp and the landings, unless interference limits such an extension.

4.3.3 The clearance between the handrail and the mounting surface or any protrusions from this surface shall be 38 mm (1½ in.). The handrail shall project no more than 89 mm (3½ in.) into the required minimum egress width. The vertical clearance in a recess shall be in accordance with the provision in 4.4.5.

4.3.4 The hand-grip portion of the handrail shall be not less than 32 mm (1¼ in.) nor more than 51 mm (2 in.) in outside diameter.

4.4 *Transfer Rail Design*:

4.4.1 Transfer rails shall be designed to permit continuous sliding of the arm and hand supporting the body weight during transfer. The hardware chosen for attaching the transfer rails shall be such that projecting lugs, devices, or other construction elements shall not interrupt the continuous sliding of arm or hand or catch loose clothing. The transfer rails, including their fasteners, shall have no sharp edges or dangerous protrusions. The transfer rail top surface shall not be abrasive.

4.4.2 Transfer rails shall be returned to supporting walls or otherwise arranged to avoid projecting rail ends.

4.4.3 The clearance between the face of the transfer rail and that of the mounting surface or any protrusions from this surface shall be 38 mm (1½ in.).

4.4.4 The hand-grip portion of the transfer rail shall have a perimeter of not less than 102 mm (4 in.) nor more than 165 mm (6½ in.), and a maximum to minimum cross-sectional dimension ratio of not more than two.

4.4.5 Transfer rails shall not be located in a wall recess unless this recess is not more than 76 mm (3 in.) deep and extends at least 457 mm (18 in.) above the top of the transfer rail, with the extension parallel with the wall surface or sloping from the depth of the recess to the wall surface above the recess in such a way that grasping of the transfer rail and transfer of the body weight are not impeded.

4.5 *Special Consideration Concerning Performance of Structural System*—In the event of lateral loading resulting from wind and seismic forces, the designer of the building shall evaluate the railing system for not adversely affecting the functioning of the structural system of the building.

4.6 *Permissible Dimensional Tolerances*, except where indicated otherwise:

4.6.1 Fabrication tolerances of components shall be within ±1½ mm (1⁄16 in.).

4.6.2 Alignment tolerances of installed products shall be within ±6 mm (¼ in.) within a length of 6.1 m (20 ft).

5. Significance and Use

5.1 Metal railing systems and rails for buildings usually are designed, manufactured, and installed to withstand forces potentially exerted by the building users.

5.2 The metal railing systems and rails shall not be considered a part of the structural system of the building unless this is expressly provided for in the design.

6. Design Considerations

6.1 *Purpose and Limitations*:

6.1.1 The principal purpose of metal railing systems and rails is to provide protection for building users against accidental falls within and beyond, and to prevent passage beyond, the accessible area defined by the system. Railing systems and rails are usually not provided at the landing side of loading docks and where the vertical distance between adjacent levels is 0.60 m (24 in.) or less, or where there are less than three risers in a stair-flight run.

6.1.2 The principal purpose of rails is to provide a means of assisting in the support of the building users, such as when ascending and descending stairs and when transferring the body weight of physically handicapped persons. In different environments and for different applications, these building elements serve different purposes; therefore, the design and performance requirements vary. Applicable building specifications, codes, standards, and other regulatory documents shall be consulted.

6.2 *Special Consideration of Adverse Exposure Conditions*—Provisions shall be made to protect railing systems and rails as well as their anchorages against deterioration resulting from adverse environmental conditions.

7. Minimum Criteria for Static Loads and Deflections During Testing in Accordance with Test Methods E 894 and E 935

7.1 *Load Criteria*:

7.1.1 The installed railing system shall withstand a minimum concentrated test load of 890 N (200 lbf) and a minimum uniformly distributed test load of 730 N/m (50 lbf/ft) applied to the top of the railing system where appropriate (see 7.1.9), in both horizontal and vertical downward directions. The horizontal and vertical loadings as well as the concentrated and uniformly distributed test loads shall not be applied concurrently. The exceptions to these test loads are indicated in 7.1.2-7.1.5. The test loads are applicable for railing systems with supports not more than 2.44 m (8 ft) apart. When subject to impact or panic loading, the designer shall evaluate the system for increased test-load requirements.

7.1.2 Where the railing system is installed in one- or two-family dwelling units, these minimum concentrated and uniformly distributed test loads shall be 890 N (200 lbf) and 290 N/m (20 lbf/ft), respectively.

7.1.3 Where the railing system is installed in public assembly buildings with rooms and spaces designed for use by 50 or more persons simultaneously, these minimum concentrated and uniformly distributed test loads shall be 1330 N (300 lbf) and 730 N/m (50 lbf/ft), respectively.

7.1.4 Where the railing system is installed in public assembly buildings with the area protected by the railing system only accessible, that is without any physical restrictions to maintenance personnel, these minimum concentrated and uniformly distributed test loads shall be 890 N (200 lbf) and 290 N/m (20 lbf/ft), respectively.

7.1.5 Where the railing system is installed in public assembly buildings with the area protected by the railing system directly accessible from a public assembly area and with the width or depth, or both, of this protected area exceeding 1.22 m (4 ft), the minimum concentrated and uniformly distributed test loads in the horizontal direction shall be 1620 N (365 lbf) and 880 N/m (60 lbf/ft), respectively.

7.1.6 The minimum concentrated test loads to be applied in the horizontal and vertical downward directions nonconcurrently to a transfer rail at any point shall be 1110 N (250 lbf).

7.1.7 The minimum horizontal test load to be applied to the infill area of a baluster or panel railing system (see Test Method C of Test Methods E 935) shall be 220 N (50 lbf), distributed over any round or square area of 0.1 m^2 (1 ft^2) located anywhere within the infill area.

7.1.8 The minimum horizontal test load to be applied by a penetration cone to the infill area of a baluster or panel railing system (see Test Method D of Test Methods E 935) shall be 220 N (50 lbf).

7.1.9 The concentrated test load shall be applied with a loading bar of appropriate shape and a length of 150 mm (6 in.), to the top of the rail nonconcurrently at the line of vertical support at the rail-end post and at the rail midspan between the three posts (see Fig. 1). If an end post is not included in the rail system to be evaluated, the load shall be applied at the midspan of the rail system. The system shall be preloaded with a load equal to 50 % of the required test load. After release of the preload to 50 % of the preload, the test loading shall be initiated.

7.2 *Deflection Criteria*:

7.2.1 The maximum allowable deflection at the required test load, measured at the top rail at the point of load application and from the position of the rail after release of the preload, shall not be more than described in 7.2.2-7.2.4.

7.2.2 When the load is applied at the line of vertical support, the horizontal deflection shall not exceed the rail height (h) divided by 12, or $h/12$, with h being the distance between the surface of the post anchorage and the top of the top rail.

7.2.3 When the load is applied at the midspan of the rail, the horizontal deflection shall not exceed the sum of the rail height (h) divided by 24 plus the rail length (l) between the vertical supports divided by 96, or $h/24 + l/96$.

7.2.4 When the load is applied at the midspan of the rail, the vertical deflection shall not exceed the length (l) divided by 96, or $l/96$.

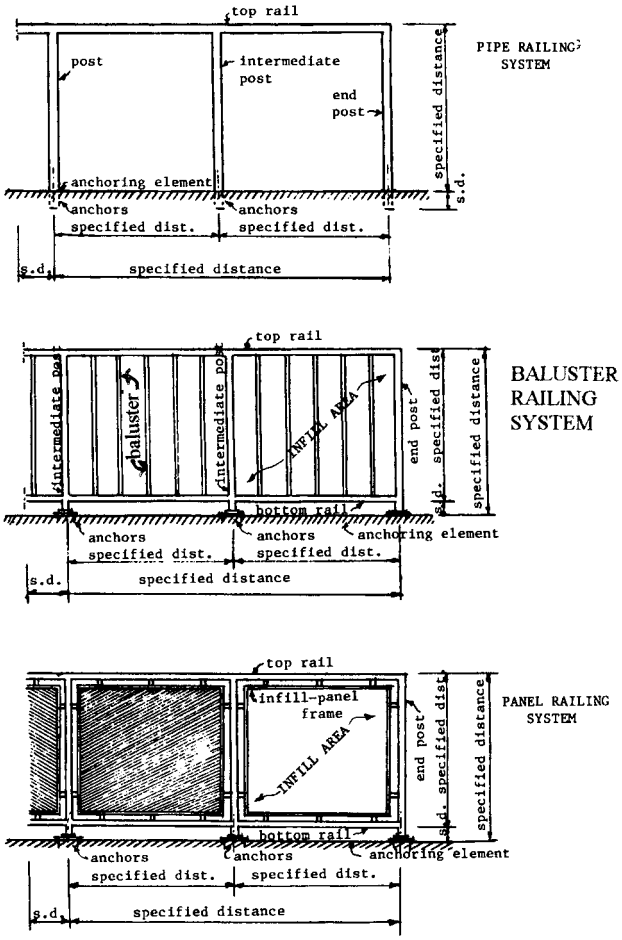

FIG. 1 Front Views of Sections of Three Typical Railing Systems

7.2.5 Residual deflection at the released test load, that is at 50 % of the preload, shall not exceed 20 % of the deflection permitted in 7.2.2-7.2.4 or 13 mm (½ in.), whichever is smaller.

8. Product Condition

8.1 *Structural System*—The structural elements and components of which the railing or rail consists shall be in accordance with the materials and configurations specified.

8.2 *Installation*—The railings and rails shall be installed in accordance with the manufacturer's specifications or, where specific variations are justified by the designer and approved by the authority having jurisdiction, in accordance with good field practice.

8.3 *Performance*—The railings and rails shall perform in conformance with the test criteria in Section 7.

9. Keywords

9.1 buildings; deflections; design; guardrail systems; handrail systems; loads; railing systems (metal); rails; residual deflections; stair-rail systems; tests; transfer rail systems

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