

ANSI/NISO Z39.73-1994 (R2012)

ISSN: 1041-5653

Single-Tier Steel Bracket Library Shelving

Abstract: This standard establishes minimum performance requirements for freestanding single-tier steel bracket shelving for use primarily in libraries.

An American National Standard
Developed by the
National Information Standards Organization

Approved December 14, 1994
by the
American National Standards Institute
Reaffirmed February 22, 2012

Published by the National Information Standards Organization
Baltimore, Maryland, U.S.A.

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Published by
NISO
3600 Clipper Mill Road
Suite 302
Baltimore, MD 21211
www.niso.org

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ISSN: 1041-5653 National Information Standards series

ISBN: 978-1-937522-32-2

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Foreword

(This foreword is not part of the Single-Tier Steel Bracket Library Shelving, ANSI/NISO Z39.73-1994 (R2012). It is included for information only.)

About This Standard

In 1988 the Equipment Committee of the Buildings and Equipment Section of the American Library Association's Library Administration and Management Association asked Library Technology Reports to undertake a comprehensive study of library shelving. This standard is based on the results of that study as well as earlier research sponsored by LTR and the Library Technology Program. It was prepared by Howard S. White, editor, *Library Technology Reports*, American Library Association. An early draft of this standard was approved by an ad hoc Library Shelving Subcommittee that met in the early 1980s. Representing various library shelving companies were the following industry representatives: Andrew Fenton, Thomas E. Hovey, Bruce Pike, Lawrence Rice, and Robert Trelease. Representing the interests of libraries were Nancy McAdams, a facilities planner for the University of Texas at Austin; Robert Rohlf, director, Hennepin County Library and a well-known library buildings consultant; and Frazer Poole, internationally acclaimed library facilities expert and also the first executive director of ALA's Library Technology Program from 1959 to 1963. Howard S. White, editor of *Library Technology Reports*, was the secretary to this subcommittee.

Reaffirmation

This standard was reaffirmed by NISO Voting Members on January 11, 2012 and by ANSI on February 22, 2012.

Suggestions for improving this standard are welcome. They should be sent to the National Information Standards Organization, 3600 Clipper Mill Road, Suite 302, Baltimore, MD 21211.

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Single-Tier Steel Bracket Library Shelving

1 Scope

1.1 Description

This standard establishes minimum performance requirements for the steel shelving generally known as single-tier bracket (freestanding) bookstack, consisting of two upright support columns per modular section with adjustable shelves cantilever-hung on brackets on both sides of the uprights. Such shelving conforms to three criteria.

1.1.1 Shelf Length and Width

Shelves are of uniform lengths and widths, formed of sheet metal, with cantilever-hung brackets that secure the shelves to the uprights.

1.1.2 Shelf Adjustability

Shelves are easily adjustable up and down, in one-inch increments, without tools.

1.1.3 Design Use

This shelving is designed primarily for use in libraries.

1.2 Exclusions

It is not the purpose of this standard to describe the weight, thickness, composition, size, or configuration of structural members, nor the method of application, composition, or thickness of the finish.

This standard does not apply to the kinds of shelving described below in 1.2.1 and 1.2.2.

1.2.1 Four-Post Shelving

Four-post shelving consists of four angle-iron uprights per section with shelves hung by bolts or clips, designed primarily for use in warehouses or for industrial or commercial storage.

1.2.2 Case Shelving

Case shelving consists of full panel backs and tops, and end panels made to receive the shelves in slots.

1.3 Application

Although requirements for steel bracket shelving may differ somewhat according to the kind of library and its collections, this standard specifies the minimum performance characteristics for such shelving for book collections in public, school, academic, and research libraries in the United States.

2 Definitions

Adder-section: See Starter-adder construction.

Anneal: To heat metal or glass, then cool to remove internal stresses and to make less brittle.

Bracket: The hooked brace supporting a cantilevered shelf. See Figure 1.

Canopy or top plate: An optional covering panel over a section or several sections of bracket shelving. See Figure 5.

Closed-base: Section construction in which a kickplate or strip closes the space between the floor and the base shelf. See Figure 2.

Cold roll: To roll sheet metal at room temperature to reduce thickness or harden. The result is a smooth finish and improved resistance to fatigue.

Double-faced: Two sections of shelving back to back, with shelves on each side hung from the same pair of upright posts or panels. See Figure 3.

End panel or plate: An optional rectangular sheet of metal, wood, or laminate, the height of a section, fitted on one or both ends of a range. See Figures 3, 4, and 5.

Flange: A rib or rim, for strength, guiding, or stability, or for attachment to another object. The flange of steel shelves is formed by two or three bends along their longitudinal edge or edges.

Floor loading: The weight of a single-tier bookstack filled to capacity with books. This has been estimated to be 35 lb per cubic foot (0.45 kg/m³) of range, or 150 lb per square foot (730 kg/m²).

Freestanding: Standing without support. As used in the shelving industry this term can be ambiguous. Double-faced sections of bracket shelving with bases 20 in (51 cm) or 24 in (61 cm) deep, and at least 2 inches deeper than the shelves they support, can be freestanding according to some manufacturers, but some authorities recommend that all ranges 78 in (198 cm) high or higher be anchored to the floor, or braced with top tie struts. The term *freestanding* is also applied to all shelving designed to rest on the building floor, regardless of whether it should be braced, to distinguish it from multitier shelving. In this sense, it is synonymous with *single-tier*, which is the better term because single-tier does not imply *unbraced*, as does freestanding.

Gauge or gage: A standard measure of thickness or diameter. The higher the gauge number, the thinner the material. For the hot and cold rolled sheet steel used for shelving, common U.S. Standard gauge numbers are 13 (.0897 in (2.28 mm)), 14 (.0747 in (1.90 mm)), 15 (.0673 in (1.71 mm)), 16 (.0598 in (1.52 mm)), 17 (.0538 in (1.37 mm)), and 18 (.0478 in (1.21 mm)). It should be noted that a gauge designates a range of thicknesses that can vary between 10% and 12%. For this reason specifications should specify thicknesses in inches or mils (meters or millimeters) rather than in gauges.

Gusset: A triangular steel plate fastened as a brace to a shelving upright and to the floor, or to the carriage of a movable-compact unit. Also called a *web stiffener*.

Nominal dimensions: Conventional, rather than actual, measurements. The nominal depth of a bracket shelf is the distance from its front edge to the center line of the upright, which is about an inch more than the actual depth of the shelf. Shelves that measure 7 in (17.78 cm), 9 in (22.86 cm), and

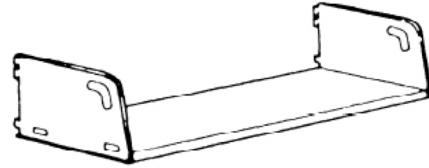


Figure 1: A bracket shelf with brackets
Courtesy Advance Manufacturing

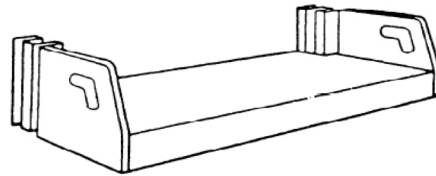


Figure 2: Bracket closed-base shelf
Courtesy Advance Manufacturing

11 in (27.94 cm) between their front and rear edges are said to have nominal, usable depths of 8 in (20.32 cm), 10 in (25.4 cm), and 12 in (30.48 cm) without extending beyond the center line of a double-faced section. The nominal length of a shelf is the length of a section measured between upright center, usually 36 in (91.44 cm). The nominal length may be 0.5 in (1.25 cm) longer than the usable inside surface of the shelf between brackets or upright panels.

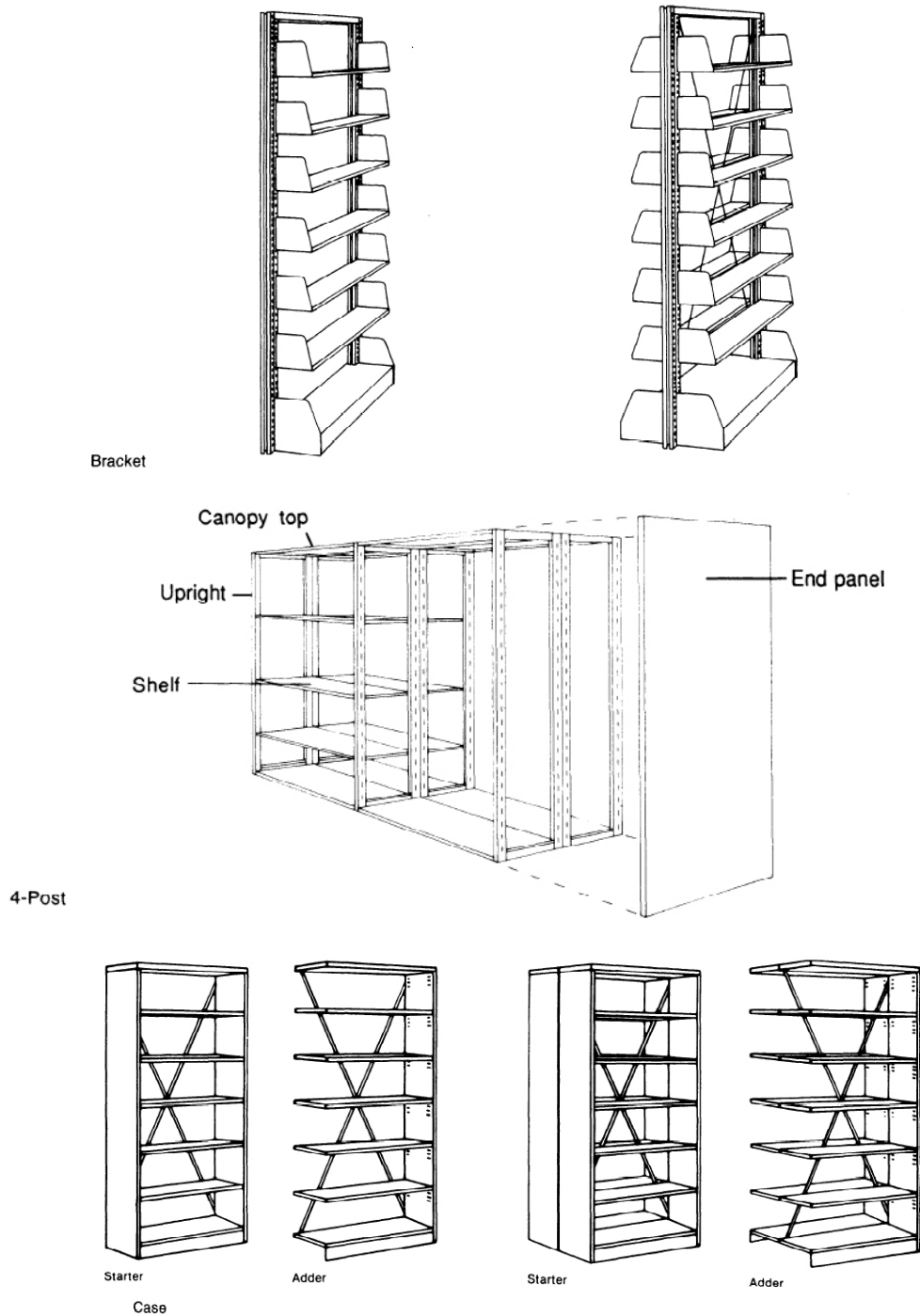


Figure 3. Single- and double-faced bracket, double-faced four-post, and single- and double-faced case

Courtesy Library Bureau, Montel, and InterRoyal

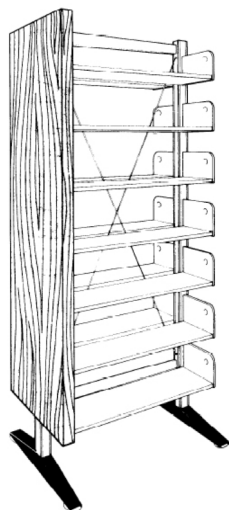


Figure 4: Open-base (T-base) bracket section with end panel and sway braces
Courtesy Estey Corporation

Open base: Section construction in which the space between the floor and the base shelf is left open. See Figure 4.

Periodical shelving: Shelves or sections designed to display the covers of periodicals or magazines. See Figure 6.

Pickle: To remove oxide or mill scale from the surface of a metal by immersing it in an acidic or alkaline solution.

Range: Two or more sections locked or bolted together in one continuous row. See Figure 5.

Section: A single modular unit, single- or double-faced, consisting of the spreaders and uprights of one frame and the shelves suspended from it.

Spreader, tie channel, or tie bar: The upper and lower horizontal members of the rectangular frame of a section of bracket shelving of which the uprights form the vertical members.

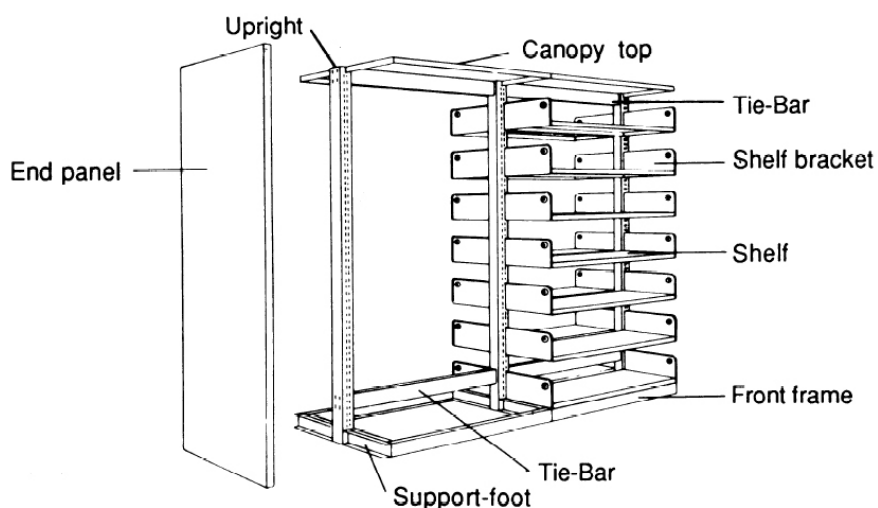


Figure 5. Two-section range of double-faced, closed-base bracket shelving, one section with shelves and one without shelves
Courtesy Montel

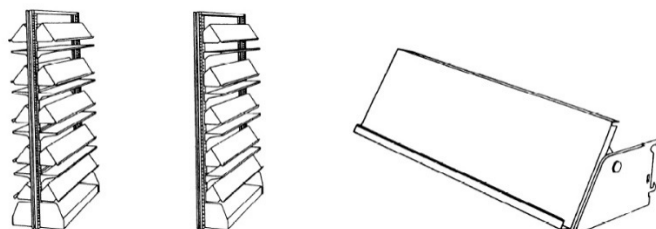


Figure 6. Periodical section, double- and single-faced bracket, and hinged display and storage shelf
Courtesy Library Bureau

Starter-adder construction: Shelving design in which the uprights are locked, rather than welded, to the horizontal members, and in which the second and subsequent sections of a range share the upright of the preceding section. For lateral stability the starter-adder configuration usually requires rod and turnbuckle sway braces on the first and on every fourth or fifth section of a range. See Figure 7.

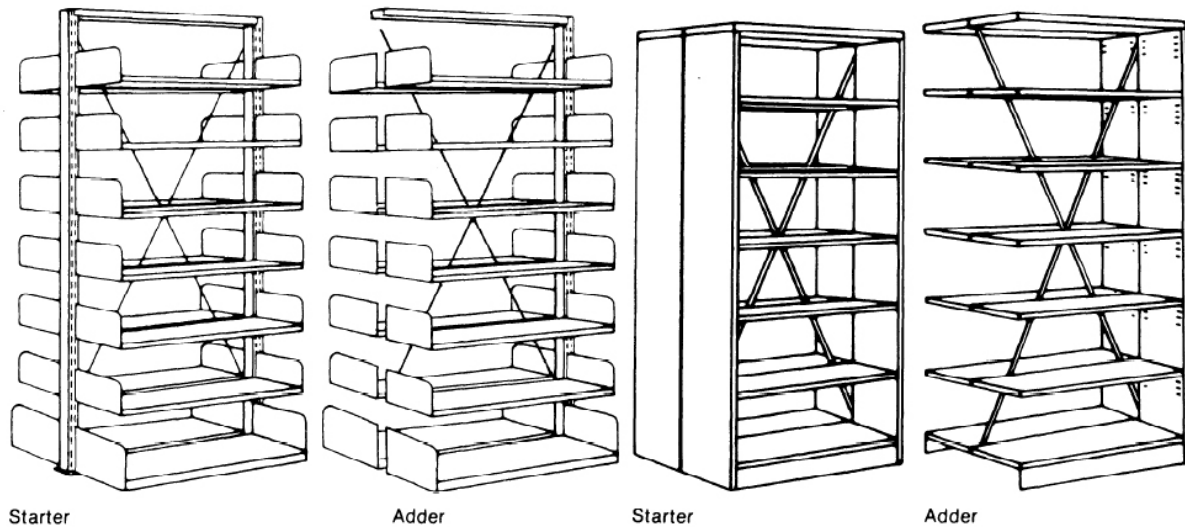


Figure 7. Starter-adder sections, double-faced bracket and case, with rod and turnbuckle sway braces
Courtesy InterRoyal

Sway brace: A brace for longitudinal stability consisting of either a rod and turnbuckle mounted in a diagonal pair from a pair of uprights on every fourth or fifth section, or one additional spreader in every section, as in Figure 8.

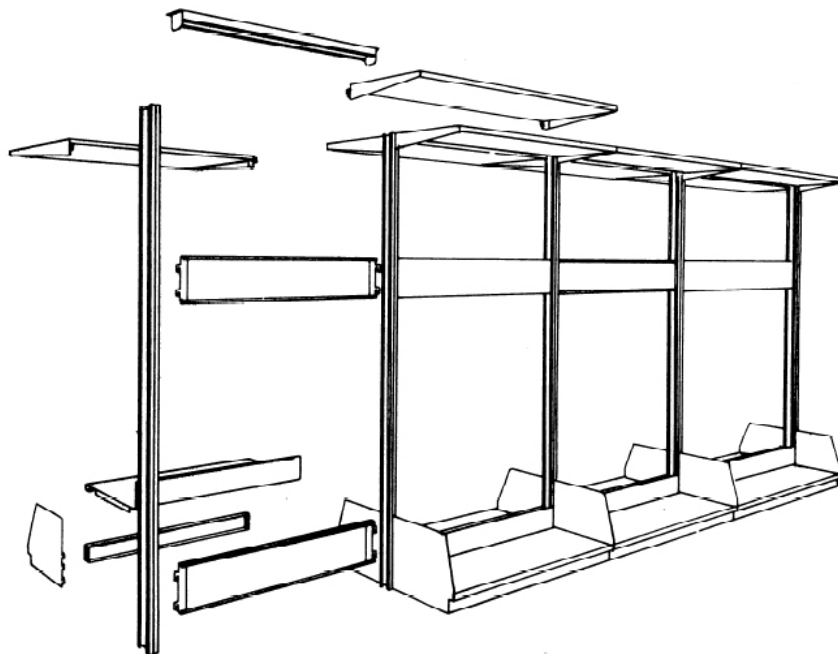


Figure 8. Starter-adder sections, double-faced bracket, with additional spreader sway braces
Courtesy Filing Equipment, Inc.

T-base: Open base bracket design in which the uprights and their bases form an inverted T. See Figure 4.

Tie channel or bar: See **Spreader**, **tie channel**, or **tie bar**.

Top tie strut: A transverse bar, usually U-shaped, bolted across the tops of two or more ranges to stabilize them. Also called **top bracing**.

Transverse strut: See **Top tie strut**.

Unit construction: Shelving design in which the frame for each section is a complete welded rectangle. Compare with **Starter-adder construction**. See Figure 9.

Web: The sides of the upright post, the face of which is perforated to receive bracket hooks.

Web stiffener: See **Gusset**.

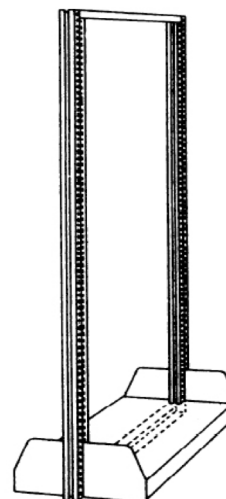


Figure 9: Unit (welded) bracket frame
Courtesy Library Bureau

3 Test Sample

3.1 Examination of Steel Shelving

To examine steel shelving for compliance with the performance characteristics described herein, it is necessary to obtain a sample range of two sections from the normal production of the manufacturer. A section shall consist of a double-faced unit of modular length (usually 3 ft) with twelve 10-inch (nominal) adjustable shelves, base shelves, uprights, and other parts standard with the particular brand of shelving. For open-based shelving (i.e., designed without a closed base), fourteen 10-inch (nominal) adjustable shelves shall be required. This sample range shall consist of two sections joined together to form a continuous range.

3.2 Sections

The sections shall have uprights 84 in (2.13 m) or 90 in (2.28 m) high. The uprights shall be furnished with protective cushions and leveling devices when these are standard with the equipment. The sections shall be evenly spaced on modular centers by spreaders (top tie channels) designed so that the range can be easily assembled, disassembled, reassembled, and extended in length. Ranges shall be braced in accordance with the manufacturer's recommendations.

3.3 Range

The range shall be installed by the manufacturer or by its designated agent, or, when the manufacturer declines to take this responsibility, by a competent installer who will follow the detailed instructions of the manufacturer.

3.4 Load-Bearing Capability

To test the load-bearing capability of the structure, each of the two sections of the range shall have mounted on it twelve adjustable shelves, six on each side, equally spaced, and a base equivalent to two shelves. When the design is open base, each section shall have mounted on it fourteen adjustable shelves, seven on each side, equally spaced, with the bottom shelves resting on the floor if possible.

4 Appearance

4.1 Condition of Finish

4.1.1 Significance

The shelving finish should be smooth and uniform, without runs, wrinkles, grit, or “orange peel” effects, and should show no areas of thinness, exposed substrata, or color separation.

4.1.2 Procedure

All parts – shelves, brackets, uprights, and supports – are closely examined for any signs of faults in the finish, as listed in 4.1.1.

4.1.3 Specification

There should be no faults in the finish. The manufacturer shall supply materials to correct any scratches, chipping, or other damage that may have resulted from shipping or installation.

5 Design Characteristics

5.1 Hazards to Books or People

5.1.1 Significance

Properly formed and assembled units should have minimal gaps between the ends of abutting shelves or brackets. Properly finished parts should be free of burrs or sharp edges.

5.1.2 Procedure

Properly assembled units are inspected for evidence of burrs or sharp edges. Gaps between the ends of shelves are measured.

5.1.3 Specification

Gaps are not to exceed 3/32 in (2.4 mm). There should be no burrs or sharp edges.

5.2 Ease of Hanging Shelves

5.2.1 Significance

Shelves should be so designed and constructed that hanging them or changing their positions on the uprights can be done easily without disturbing other shelves or the stability of the section or range.

5.2.2 Procedure

Both empty and loaded shelves are removed and rehung. Brackets, hooks, and lugs are checked for alignment with corresponding slots.

5.2.3 Specification

One person should be able to remove and rehang shelves with no difficulty.

6 Physical Characteristics Determined by Testing

6.1 Lateral Deflection or Deviation of the Uprights under Loads

6.1.1 Significance

Properly constructed and installed shelving should not lean, sag, or bend excessively when loaded, even when the load is unbalanced. Excessive lean or bend could cause a shift in the center of gravity of the section or range, produce an unsightly appearance, and indicate a generally weak structure.

6.1.2 Test Method

(a) The sample range is properly installed and leveled, the shelves evenly spaced on the uprights, the topmost shelves adjusted to the highest possible position on the uprights.

(b) With the shelves empty, the position of the first or end upright and of the center upright are noted and recorded. Subsequent lateral deflection measurements are made with respect to the initial unloaded position of the uprights.

(c) The shelves on one side of the range are loaded from the top down with the weight distributed uniformly over each shelf @ 50 lb (22.6 kg) per lineal ft (3.4 dm) or 150 lb (67.5 kg) per 3-ft (.965 m) shelf.

(d) With the shelves on one side thus loaded with 2,100 lb (952.5 kg), the second measurements of deflection are made and noted as in (b).

(e) The shelves on both sides of the range are then loaded in the same manner as in (c).

(f) With the shelves on both sides of the range thus loaded with 4,200 lb (1905 kg), the third measurements of deflection are made and noted as in (b).

(g) All loads are removed from the shelves and final measurements are made as in (b) to determine any permanent deflection caused by the tests.

6.1.3 Specification

The following deflections, measured in 1/64 in (0.40 mm) increments, are not to be exceeded (deflections less than 1/64 in (0.40mm) are considered not measurable):

	in	(mm)
Before loading	0	(0)
Loaded on one side @ 50 lb (22.68 kg) per lineal ft (3.4 dm)	64/64	(25.4)
Loaded on both sides @ 50 lb (22.68 kg) per lineal ft (3.4 dm)	20/64	(7.9)
After removal of loads	8/64	(3.2)

6.2 Deflection of Shelves under Load (Shelf Sag)

6.2.1 Significance

Shelves of proper thickness, quality, and configuration should not deflect (sag) excessively when loaded with heavy library material. Excessive yield would produce an unsightly appearance, cause the brackets to tilt inward, produce unsightly and dangerous gaps, and indicate the possibility of a generally weak structure.

6.2.2 Test Method

- (a) Five shelves are selected at random and hung on the uprights.
- (b) With the shelves empty the first measurements of deflection from flatness are made and recorded.
- (c) Loads of 50 lb (22.68 kg) per lineal shelf foot (3.4 dm) (150 lb (67.5 kg) per 3-ft (.965 m) shelf) are applied, distributed uniformly over the top surface of each test shelf.
- (d) After 24 hours, the second measurements of deflection are made and recorded.
- (e) The shelves are then unloaded and after six hours the measurements of permanent deflection from flatness are made and recorded.

6.2.3 Specification

The following deflections, measured in 1/64 in (0.40 mm) increments, are not to be exceeded (deflections less than 1/64 in (0.40 mm) are considered not measurable):

	in	(mm)
Before loading	0	(0)
Loaded @ 50 lb (22.68 kg) per lineal ft (3.4 dm)	12/64	(4.8)
After removal of loads	0	(0)

6.3 Longitudinal Deflection of Uprights under Horizontal Pull

6.3.1 Significance

Uprights should not deflect or lean from the vertical when subjected to a horizontal force. Excessive lean will produce an unsightly appearance and indicate the possibility of a generally weak structure.

6.3.2 Test Method

- (a) A properly installed and leveled two-section double-faced range has its adjustable shelves installed and empty, as in 6.1.2(a).
- (b) 200 lb (90.72 kg) are loaded on each of its four base shelves, or on each of the lowest adjustable shelves of open-base designs.
- (c) A 100-lb (444.8 N) force, horizontal and parallel to the long axes of the range, is applied against an end upright, from a point 48 in (122 cm) above the floor.
- (d) Deflection from the vertical, in 1/64 in (0.40 mm) increments, is measured after the force has been applied for 10 minutes.

6.3.3 Specification

The following deflection is not to be exceeded (deflection less than 1/64 in (0.40 mm) is considered not measurable):

Horizontal Pull

100 lb x 10 min	16/64 in
(444.8 N x 10 min)	(6.3 mm)

6.4 Gloss of Finish

6.4.1 Significance

Properly finished shelves shall have a uniform, overall pleasing gloss, neither so shiny as to be a distraction, nor too dull.

6.4.2 Test Method

Gloss shall be determined by a 60-degree gloss meter according to ASTM Method 0523-53T. Two random readings are taken on each of five randomly selected shelves. The average reading is reported.

6.4.3 Specification

Average specular gloss values below 30 or above 60 are considered to be out of specification.

6.5 Adhesion of Finish

6.5.1 Significance

A proper finish should protect the metal substratum and not separate from it. There should be no observable effect or damage when the finish is subjected to the tests described in 6.5.2 and 6.5.4, which are designed to measure the adhesion of the finish to the metal substratum.

6.5.2 Test Method-Bending

- (a) On a 0.25-in (.635 cm) diameter mandrel, a test panel is placed finish side up. The edges of the panel should be equidistant from the mandrel and the grain of its steel parallel to its length.
- (b) The panel is bent double (180 degrees) in approximately one second.
- (c) A second test panel is placed over the same mandrel, in the same manner, except that grain of its steel should be transverse to length of the mandrel.
- (d) This second panel is bent double (180 degrees) in approximately one second.

6.5.3 Specification

Adverse effects, other than cracks at either end of the panels, extending no more than 1/4 in, shall be noted. (This is a modification of Federal Test Standard No. 141a, Method 6221.)

6.5.4 Test Method-Impact

- (a) Over a 1.25-in (3.17 cm) diameter opening, a test panel is laid, finish side up.
- (b) A 2-in (5.08 cm) diameter steel ball is dropped from 10.5 in (26.67 cm) above the opening onto the panel.
- (c) A second test panel is laid, finish side down, over the same opening.
- (d) A 2-in (5.08 cm) diameter steel ball is dropped from 10.5 in (26.67 cm) above the opening onto the panel.

6.5.5 Specification

Cracks, hairline cracks, or chipping of the impact area is noted. There should be no adverse effects.

6.6 Resistance of the Finish to Abrasion

6.6.1 Significance

A proper finish should resist the abrasion normally encountered. The constant sliding of stored materials can cause wear-through of defective finish, resulting in an unsightly appearance and exposure of the metal to rust.

6.6.2 Test Method

- (a) Three shelves are selected at random.
- (b) The film thickness of each of them is measured on six randomly selected areas, three on the top and three on the front edge.
- (c) The falling sand abrasion test, performed according to ASTM Method D968-51, is run on the three locations found to have the thinnest film.
- (d) The average number of liters of sand required to expose the substratum in these three areas is computed and recorded.

6.6.3 Specification

The minimum number of liters of sand needed to expose the substratum should be 30.

6.7 Resistance of the Finish to Acids and Chemicals

6.7.1 Significance

Shelving should be protected by a finish capable of withstanding exposure to acids and chemicals likely to be encountered in normal use, in cleaning, and as a result of accidents.

6.7.2 Test Method

- (a) Four circular pieces of 1.5-in (3.81 cm) diameter filter paper are soaked in the chemicals to be tested: one in a 95 % solution of alcohol, one in a 10 % solution of acetic acid, one in machine oil, and one in undiluted household ammonia.
- (b) Each of these four pieces of soaked filter paper is placed on the finish side of a test shelf and covered with a watch glass to inhibit evaporation.
- (c) Fifteen minutes after these four solutions have been applied, a fifth piece of filter paper is soaked in a 10% solution of lye, placed on the finished side of the same shelf, and covered with a watch glass.
- (d) Thirty minutes after the first four solutions have been applied, all five pieces of filter paper are removed, and
- (e) all test surfaces are rinsed with water and wiped dry with a clean rag.
- (f) Evidence of finish discoloration, softening, or blemish is noted.

6.7.3 Specification

There should be no detectable adverse effects.

6.8 Resistance of the Finish to a Lighted Cigarette

6.8.1 Significance

Shelving should be protected by a finish capable of withstanding a high degree of heat, equal to that of a lighted cigarette.

6.8.2 Test Method

- (a) A lighted cigarette is placed on a shelf with the lighted end overhanging the edge of the shelf.
- (b) The cigarette is allowed to burn until it is completely consumed.
- (c) After the cigarette has ceased burning, the surface of the shelf is wiped with a damp cloth and a mild detergent, and rinsed with cold water.
- (d) Any adverse effects are noted.

6.8.3 Specification

No adverse effects should be detected.